

Population and Land in World Agriculture

RECENT TRENDS AND RELATIONSHIPS

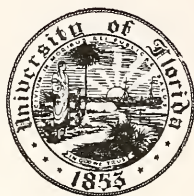
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POPULATION AND LAND IN WORLD AGRICULTURE

Dedicated to my wife, Asha

Population and Land in World Agriculture

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FOREWORD

To my knowledge, the present study is the most thorough ever made, on a comparative international basis, of a neglected but important subject--changes in the agricultural population in relation to agricultural resources. Despite the concern everywhere with cities and urbanization, agriculture remains the world's biggest industry. It directly engages approximately half the world's workers, indirectly an additional share. Further, in the world as a whole the agricultural population is increasing. Nobody knows the exact rate of increase, because data are not available for all countries, but the world's "rural population," which is mostly agricultural, rose by 24 percent between 1950 and 1970. In the less developed countries (in which the rural population is overwhelmingly agricultural) the rural increase during the two decades was 55 percent.

Sometimes the role of agriculture in today's world is underestimated because of two circumstances. First, everywhere, including the agrarian nations, the proportion of agriculturalists among all workers is declining; second, in industrial countries the absolute number is falling. The universality of the proportional drop, however, does not imply an absolute decline. The agrarian countries, because they constitute a majority of mankind and have populations that are skyrocketing, give the entire world an expanding number of agriculturalists.

What about the resources to go with this rising agricultural labor force? That, clearly, is a crucial question, and fortunately, though difficult to answer, it is less difficult than the same question with respect to most other resources. In agriculture the principal resource is land, and its types and extent are fairly well known. The author has shown ingenuity in distinguishing different uses of land and in finding evidence of shifts in the uses under demographic stress.

All told, Dr. Kumar has assembled an impressive array of data from as many countries as possible regarding the agricultural population and labor force, on the one hand, and the land in various categories on the other. He has done this for two dates, thus allowing the computation of rates of change in differing regions and at different economic and technological levels. His main purpose is not to treat human and natural resources in isolation from each other but together, because the abundance or scarcity of land impinges most directly on those who use land to make a living. A central question, for example, is the degree

to which, in countries where the farming population is rising, land utilization is also rising. If the land supply is not expanding commensurately, agricultural density and probably rural poverty are becoming worse; if, on the other hand, farmland is expanding more rapidly, the growing farm population does not necessarily mean more rural poverty. In the history of the industrial countries, development was accompanied and fostered by a long-run decline in agricultural density. The earlier part of this trend came from a faster expansion of exploited land than of farm population, but the latter part was due to virtual stability in the land supply with a rapid drop in farm population. In today's developing countries, conditions are sharply different. In view of just one difference--their much faster population growth--one could hardly expect these countries to repeat the same evolution, and Dr. Kumar finds that they are not doing so; but he also finds that in regard to agricultural density developing countries are far from being all alike.

This book is a companion study to the two-volume work, World Urbanization, 1950-1970, already in the Population Monograph Series. That work dealt with the rural as well as the urban population, but not with the agricultural labor force or agricultural land. Dr. Kumar, who is now on the faculty of the International Institute for Population Studies at Bombay, has made good this omission. In his thorough and sophisticated analysis of the two main components of the world's largest industry, he has made a major contribution to our understanding of contemporary world development. Future studies of these components will rest on the excellent foundation he has laid.

Kingsley Davis

International Population and Urban Research
University of California, Berkeley
April 1973

ACKNOWLEDGMENTS

During the summer of 1968 I began working with Professor Kingsley Davis as a research assistant on an international study of agricultural population. Gradually I realized the great potential of this research and the contribution it would make to the general study of population growth. I selected the subject as the topic of my doctoral dissertation. There have been many periods of discouragement in the seemingly endless research involved, and at times I have wanted to abandon the project. However, Professor Davis has repeatedly rescued me. He has been helpful to me in so many ways that I cannot begin to express the full extent of my gratitude to him in these few lines. He has devoted many hours to helping me, and his critical reading of virtually every sentence of the original draft of this study led me to make many important changes.

Professor George Kuznets has also been extremely helpful. He spent a considerable amount of time discussing my research with me; I am particularly grateful for his criticisms relating to Chapter VI. Professor Nathan Keyfitz also made several valuable criticisms and suggestions concerning the original draft.

The major part of the research for this study was completed at International Population and Urban Research (IPUR), University of California, Berkeley. Throughout the period of four years I spent at Berkeley, I had access to the excellent research facilities and enjoyed the hospitality of the staff at IPUR. For this privilege I am very grateful to Professor Davis and to Ila Jungnickel and Judith Clark, staff members of IPUR, who were especially helpful.

Professor Judith Blake Davis of the Department of Demography went out of her way to assist me during my stay at Berkeley. She was instrumental in securing various kinds of financial support for me, and through her efforts I was allowed unlimited computer time. (The research for this study was supported primarily by training grants to the Department of Demography from the National Center for Health Services Research and Development (8 TO1 HS00059) and from the Ford Foundation.)

Many of my colleagues and friends at Berkeley gave me helpful advice concerning this research. Among these I want to convey my special thanks to Eduardo Arriaga, Roger Avery, Kwan-hwa Chen, Prithwis Das Gupta, Geoffry McNicoll, Leo Schnore, George Simmons, and Jokhan Singh.

ACKNOWLEDGMENTS

My writing needed a considerable amount of editing. The brunt of the responsibility fell on Paul Gilchrist, editor for the Institute of International Studies. He has painstakingly gone over every line of the manuscript. I am indeed very grateful for his help.

In 1969 I joined the faculty of the Department of Sociology, University of Missouri, Columbia. I am very grateful to Professor Daryl Hobbs, chairman of the department, for providing the necessary facilities for me to continue my research. Most of the final draft of this work was written in Columbia, where I was fortunate to have the assistance of Jeanie Dobbs, a secretary in the Sociology department, who did an excellent job of typing the entire draft, proofreading, and editing various sections. Three other staff members of the Sociology department--Mary Grace Burroughs, Ann Wright, and Edith Pinet--were also very helpful.

While in Columbia I tried out my ideas on two of my colleagues--Professors Robert Perinbanayagam (Sociology) and Prem Singh (South Asian Studies); my sincere thanks to both of them for their patience and valuable criticisms.

Finally, but most important, I want to pay tribute to my family in India for their constant encouragement and prayers for my success. Those who are familiar with the Indian setting will realize what it means to a family when the eldest son is away from home for as long as five years. They deferred several of their most cherished desires for the sake of my pursuit of knowledge.

J.K.

Bombay, India
March 1973

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Chapter I

INTRODUCTION

This is a comparative study of agricultural populations throughout the world during the decade from 1950 to 1960. It is divided into four parts. The first part is concerned with changes in the relative size of the agricultural populations of various countries, measured in turn by the rural population, the farm population, and the male agricultural labor force between 1950 and 1960, and with the interrelationships between these three measures of the agricultural population in countries at different stages of economic growth and in different geographic locations.

The second part focuses on agricultural land, which, as an integral part of agricultural production, is a fundamental factor affecting the size and growth of the agricultural population. Agricultural land is defined as the sum of arable land, made up of fallow and cultivated land, and pasture, made up of cultivated and natural pasture. Variations in systems of cultivation in different regions of the world are analyzed by examining land-use patterns. This leads to such questions as: How did different systems of land use evolve? What factors most influence the intensity of land use? Etc.

The third, and most important, part is an analysis of the relationship between the size of the agricultural population and the amount of agricultural land through the study of several different, but related, population/agricultural densities. An attempt is made to establish the pattern of variation in densities between countries, and the pattern of change in densities from 1950 to 1960 according to the economic level and the geographic location of the countries.

In the fourth and final part, a general theory of the growth of the agricultural labor force is presented. Three hypotheses to explain the growth of the agricultural population are developed on the basis of the material presented in the earlier sections and other evidence, and then tested by means of regression analysis. A substantive discussion of the regression results leads us to a generally satisfactory explanation of the growth of the agricultural labor force.

General Remarks Concerning Agricultural Population

Historically, agriculture has played the major role in socio-economic development. Agriculture is the dominant sector

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in the earliest stages of economic growth in a society, and it retains its paramount position during a long period of economic evolution. The decline in the importance of agriculture is in direct proportion to the increase in the technological development of a society. But though mankind has already entered the space age, more than half of the world's population still derives its livelihood from agriculture.

In view of the large size of the world's agricultural population, any general theory of population change must include an explanation of the dynamics and behavior of the agricultural segment. Similarly, the agricultural sector must have a prominent place in theories of economic development and in economic policies. This study is an attempt to analyze the factors that determine the evolution of the agricultural population. We seek to understand the composition of the agricultural population, its relation to the total population, and its change over time. By using the comparative approach, we hope to obtain results that will be significant for most of the world's populations, and provide a broader perspective than would be provided by an in-depth case study. However, we have incorporated a few case studies in the text when it seemed they would clarify the discussion. The emphasis throughout is on the change in the agricultural population between 1950 and 1960, but historical material has been included in several places.

Before proceeding to discuss some specific issues, a few remarks should be made to explain our special emphasis on agricultural land. Agriculture is distinguished from other economic activities in many ways. Perhaps most important is the degree of its dependence on land. Most other industries grow vertically, but agriculture expands horizontally on land.¹

A noted agricultural economist, Karl Brandt, dismisses agricultural land statistics, and consequently land-man ratios, as invalid.² He argues that, because of the high productivity of land and labor, it is no longer necessary to cultivate land extensively; hence, the land-man ratio is a misleading and useless measure of conditions in the agricultural sector. While this

¹The importance of agricultural land and the distinguishing features of the agricultural and industrial sectors are well summarized by R. L. Cohen in The Economics of Agriculture (London: Nisbet and Company, Ltd., 1940), Chapter 1.

²In his "Comments" on "Population and Migration Factors in Rural Development," by B. N. Ganguli, in Proceedings of the Twelfth International Conference of Agricultural Economists (London: Oxford University Press, 1966), pp. 243-244.

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argument may be valid for the United States, it does not appear to hold true for the less developed countries. The results in Chapter V below show that agricultural densities in economically advanced countries are far lower than in less developed countries. This raises questions concerning the role of the population/agricultural density in determining the cultivation system and the growth of the agricultural population. Could it be, as seems to have happened in the Western European countries, that high agricultural densities lead to the elimination of fallow land, the increased use of crop rotation methods, and the out-migration of the agricultural population? Or, as in the case of Japan and Taiwan, do high agricultural densities lead to advances in agricultural technology that are suitable to small-scale farming and that require a high-level input of labor? It would seem that the responses vary according to prevailing demographic and economic conditions. Thus population/agricultural density appears to be a useful economic concept in cross-national research.

Let us turn now to examine the historical experience of the agricultural populations of a few economically advanced countries. In the light of this experience, we will formulate hypotheses that can be tested by our recent statistics (1950-1960) for both less developed and advanced countries. In general, we want to determine whether, during 1950-1960, less developed countries behaved in a manner different from or similar to the historical behavior of advanced countries. This cross-national comparison between advanced and less developed countries of the pattern of change in agricultural populations should lead to some useful findings.

Some Issues Related to Agricultural Population

It is common knowledge that during the last 100-150 years, the absolute size of the agricultural population has declined or remained stable in the industrialized countries.³ Furthermore, the non-agricultural population has increased at a rate faster than the total population. Consequently there has been a consistent drop in the proportion of population/labor dependent on agriculture.⁴

³The "frontier countries," such as the United States and Canada, are a major exception to this general statement.

⁴These findings are the result of research by many scholars, the work by Folke Dovring being most pertinent to the discussion here. See especially Dovring, "The Share of Agriculture in a Growing Population," Monthly Bulletin of Agriculture Economics and Statistics, U. N. Food and Agricultural Organization, Vol.

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Table 1 gives the proportion of the labor force in agriculture in a few economically advanced countries since 1800. It should be noted that the figures are not exactly comparable between the countries: they may be based on the male labor force, on the labor force of both sexes, or on the total population. Ideally, we would have presented statistics based on the male labor force only, but lacking the necessary data, and desiring to obtain a long historical trend, we used the data presented in Table 1. The trend since the beginning of the twentieth century in the same countries, based on the male labor force only, is shown in Table 2.⁵ A painstaking search of historical statistics, coupled with some indirect methods of estimation, could produce data on the proportion of males in the agricultural labor force for all the periods shown in Table 1. But because our purpose is only to show the trend in the relative size of the agricultural population in certain industrialized countries, little would be gained by making such an effort.

Both Tables 1 and 2 show that the relative size of the agricultural population has consistently declined over time in the countries listed. According to Folke Dovring, the rate of decline depends on the excess of the rate of increase in non-agricultural employment over the rate of growth of the total population and the initial level of agricultural population/labor force.⁶ The larger the first factor, which Dovring terms the "coefficient of differential growth," the greater the decline in the proportion of the ALF (assuming, of course, that the majority of the additional non-agricultural jobs are filled by the ALF rather than through international migration). As for the second factor--the initial level of the agricultural population--Dovring contends that when the agricultural labor force constitutes a majority of the total labor force, an appreciable decline in the ALF is unlikely because it would require a high coefficient of differential growth; for example, more than 4-5 percent per year.

VIII, No. 8-9, August-September 1959; and Land and Labor in Europe 1900-1950 (The Hague: Martinus Nijhoff, 1960).

⁵ Comparing Tables 1 and 2, we see that in the U.S. the proportion of the ALF (agricultural labor force) for males is higher than the proportion for both sexes, while the reverse is true in Japan. The most puzzling figures in the two tables are those for Sweden. There the average percentage of the male labor force in agriculture is about 40 percent less than the percentage of the total population in agriculture. This implies that the agricultural population in Sweden is dominated by young and old dependents.

⁶ Dovring, Land and Labor . . ., pp. 1-2.

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Table 1

PERCENT OF LABOR FORCE OR POPULATION IN AGRICULTURE IN
SELECTED INDUSTRIALIZED COUNTRIES: 1800-1950

Year	U.S. ALF(B) ^b	Great Britain ^a ALF(M) ^c	Sweden FARM ^d	Switzerland ALF(B)	Japan ALF(B)
1800			79.1		
1810			82.4		
1820	71.8		82.6		
1830	70.5		82.1		
1840	68.6	21.4	80.9		
1850	63.7	23.5	77.9		
1860	58.9	21.4	--		
1870	53.0	17.5	82.4		
1880	49.0	14.3	79.2		72.7
1890	42.6	11.8	75.5	37.4 (1888)	69.1
1900	37.5	9.7	69.1	--	62.0
1910	31.0	9.5	63.7	26.8	56.1
1920	27.0	8.6	60.8	--	53.6
1930	21.4	7.8	56.6	21.3	49.3
1940	17.6	--	52.3	20.8 (1941)	43.8
1950	12.4	6.2	43.5	16.5	48.3

^a The data refer to years 1841, 1851, etc.

^b ALF(B) = Agricultural labor force (Both sexes)

^c ALF(M) = Agricultural labor force (Males)

^d FARM = Farm population

SOURCES:

United States: 1820-1940: U.S. Bureau of the Census, Historical Statistics of the United States 1789-1945 (Washington, D.C., 1949), Series D1-10; 1950: U.S. Bureau of the Census, Statistical Abstract of the United States 1968, 89th ed. (Washington, D.C., 1968), Table 324.

Great Britain: 1841-1951: B.R. Mitchell, Abstract of British Historical Statistics (Cambridge, 1962), pp. 60-61.

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Table 2

PERCENT OF MALES IN AGRICULTURAL LABOR FORCE TO TOTAL LABOR
FORCE IN SELECTED INDUSTRIALIZED COUNTRIES: 1900-1950

Year	U.S.	Great Britain	Japan	Sweden
1900	41.7	9.7		48.8
1910	34.7	9.5		45.1
1920	30.5	8.6	48.2	40.8
1930	24.8	--	43.1	37.3
1940	21.7	7.8	35.7	30.7
1950	14.9	6.2	33.7	25.3

SOURCES:

United States: Gertrude Bancroft, The American Labor Force (New York, 1958), Appendix Table D-2.

Great Britain: See Table 1.

Japan: Taeuber, The Population of Japan.

Sweden: The absolute figures on the labor force for ages 15+ years are derived from the following Statistical Yearbooks of Sweden (SYB): 1900: SYB 1915, Table 14; 1910: SYB 1920, Table 24; 1920 and 1930: SYB 1935, Table 28; 1940: SYB 1947, Table 30; 1950: SYB 1957, Table 31.

SOURCES (Table 1 continued):

Sweden: 1800-1850: Dorothy S. Thomas, Social and Economic Aspects of Swedish Population Movements 1750-1933 (New York, 1941), p. 93; 1870-1950: Statistiska Centralbyran, Historical Statistics of Sweden, Population, 1720-1950, Vol. 1 (Stockholm, 1955), p. 29.

Switzerland: 1888-1950: Bureau Fédéral de Statistique, Annuaire Statistique de la Suisse 1968, p. 28.

Japan: 1880-1910: The proportions in the table are averages of proportions computed on the basis of two sets of estimates (sets A and B) of non-agricultural labor force and total labor force by James I. Nakamura, Agricultural Production and the Development of Japan 1873-1922 (Princeton, 1966), p. 148; 1920-1950: Irene B. Taeuber, The Population of Japan (Princeton, 1958), p. 87.

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Such a rate was difficult to achieve in the nineteenth or early twentieth century, and is equally unlikely in present-day societies where three-fourths of the population is dependent on agriculture. The historical experience of the U.S. and Japan (see Table 1) bears this out. It is easy to see that when the proportion of the agricultural population is less than 50 percent of the total population and is decreasing, the proportion would decline faster than in earlier periods.

At this point it is important to note the concept of "successive acceleration" propounded by Kingsley Davis.⁷ Davis points out that the rate of decline in the proportion of the labor force in agriculture, from the same initial level, is faster in countries experiencing industrialization at a later period than in those experiencing it earlier. The following table based on data obtained from Davis in 1969 demonstrates the "successive acceleration":

DECLINE IN AGRICULTURAL LABOR FORCE BY STARTING DATE
OF INDUSTRIALIZATION

Shift in Percent of ALF	Median Starting Date	Early Starting Date for Industrialization		Late Starting Date for Industrialization	
		Number of Countries	Years Required	Number of Countries	Years Required
70-60	1850	3	38	2	15
60-50	1891	4	23	3	22
50-40	1900	5	23	5	21
40-30	1910	6	26	5	11
30-20	1927	7	38	7	33
20-10	1939	5	38	5	16

⁷ This concept is discussed by Professor Davis in his book World Urbanization 1950-1970, Volume II: Analysis of Trends, Relationships, and Development (Berkeley: University of California, Institute of International Studies, 1971; Population Monograph Series).

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Another way of presenting these data (also derived from Davis) is given below:

<u>Number of Countries</u>	<u>Number of Years in Shift</u>	<u>Shift in Percent ALF</u>
5	29.0	70-60
7	22.7	60-50
10	22.1	50-40
11	21.4	40-30
14	25.2	30-20
10	26.9	20-10

These figures show that, no matter what the level of the ALF, the average number of years required to reduce the proportion of the ALF by 10 percentage points is about the same. If this trend persists in the advanced countries, as we would expect it to, the agricultural labor force in them will disappear or be reduced to negligible proportions in about 25 years. In Chapter III we will consider whether trends during 1950-1960 indicate such a future.

If such is the case among the advanced countries, what trend can we expect in the less developed countries during 1950-1960, where the average level of the ALF was more than 65 percent of the total labor force in 1950? The answer requires, among other things, a comparison of the rate of growth of the total population in less developed countries with that in advanced countries before 1930 or 1940. Dovring has pointed out that, on the basis of rates of growth over 50-year periods, no advanced country has had a rate of population growth of more than 1.4 percent per year, the average being 0.8 percent per year during 1850-1900.⁸ On the other hand, a growth rate of between 2-3 percent per year is quite common among the less developed countries today. This fact, coupled with a high initial proportion of ALF, leads to the expectation that a decline in the proportion of ALF on the order of from 70 to 60 percent or from 60 to 50 percent during 1950-1960 is highly unlikely in less developed countries. Any reduction in the absolute size of the ALF is equally unlikely, a view also advanced by Dovring. If there is any decline in the proportion of the ALF, it would be less than five percentage points in 10 years.

What about the trend in the proportion of the rural populations in industrialized countries? A table of rural populations

⁸ Dovring, Land and Labor . . ., p. 2.

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similar to that for the ALF in Table 1 (p. 5 above) would show a definite downward trend in their proportions.⁹

If the growth patterns of the rural population and the agricultural labor force are the same, the RURAL/ALF (the ratio of the rural population to the agricultural labor force) ratios would not change over time. However, as the data in Table 3 show, such is not the case. In all but one of the countries the ratios show an upward trend during the last few decades.¹⁰ (For almost 100 years the RURAL/ALF ratio in the U.S. remained at a level of 4.1-4.2, but then it began increasing.)

What does such a pattern mean? First, it implies that after a certain stage of economic development, which we may call the take-off stage, the growth of ALF is less than the growth of the rural population. Further, it indicates that at later stages of economic development, the structure of the rural population changes radically. When agriculture becomes highly commercialized and mechanized, there is a great need for people in rural areas to service the increased demand for industrial goods by the farm population. At the same time, there is a growing demand for the establishment of modern recreational facilities in rural areas. These and certain other forces, which we will discuss in Chapter III, reduce the proportion of the farm population in the total rural population. Consequently, the RURAL/ALF ratio increases as economic development advances. Hence in advanced countries we expect the RURAL/ALF ratio to have increased during 1950-1960. But we do not expect any significant change in the ratio in countries at economic levels 1 and 2 (on a 4-point scale where 4 refers to the most highly developed countries). These countries would be expected to follow the nineteenth-century experience of the U.S.--an expectation already anticipated in our analysis (see p. 7 above).

In the preceding discussion we have referred to the concept of farm population--that is, the population that derives its livelihood from agriculture. Zelinsky has called it the "basic

⁹ See, for example, Donald J. Bogue, The Population of the United States (The Free Press of Glencoe, Illinois, 1959), p. 30. In the U.S. the percent of the rural population gradually declined from 93.9 in 1800 to 41.0 in 1950. See also Wilbur Zelinsky, "Rural Population Dynamics as an Index to Social and Economic Development: A Geographic Overview," The Sociological Quarterly, Vol. 4, No. 2, Spring 1963, pp. 99-121.

¹⁰ The upward trend in Japan was reversed during 1940-1950, probably reflecting the reorganization of the agricultural sector after World War II.

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Table 3

RATIO OF RURAL POPULATION TO AGRICULTURAL LABOR FORCE (RURAL/ALF)
IN SELECTED INDUSTRIALIZED COUNTRIES: 1820-1950

Year	RURAL/ALF						
	United States		Great Britain ^a	Sweden	Switzerland	Japan	
	MF ^b	M ^b	M	M	MF	MF	M
1820	4.3						
1830	4.2						
1840	4.1						
1850	4.0		4.9				
1860	4.1		5.1				
1870	4.2		5.3				
1880	4.2		5.5				
1890	4.1		5.7		5.1 ^c		
1900	4.2	4.6	5.6	5.6	--	2.5	
1910	4.3	4.8	5.5	5.5	5.9	2.6	
1920	4.5	5.0	5.8	5.1	--	2.6	4.6
1930	5.1	5.7	6.2	5.2	6.8	2.6	4.6
1940	6.2	6.7	--	5.8	6.9 ^d	2.6	5.2
1950	8.2	9.6	7.6	6.5	8.4	2.2	4.7

^aThe data refer to years 1851, 1861, etc.

^bMF = Male and female; M = Male only.

^c1888

^d1941

SOURCES:

See Tables 1 and 2 for the sources of the agricultural labor forces. The sources for rural populations are as follows:

United States: 1820-1940: Historical Statistics of the U.S., Series B-13-23; 1950: Statistical Abstract of the U.S., Table 14. The figure used is 60,948,000; the rural population

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rural" population, distinguishing it from the "enumerated rural" population. He proposes the following hypothesis:

As a community progresses to and past a moderately advanced stage of economic and social development, the absolute size of its "basic rural" (or "landward") population will stabilize after an initial period of growth and then begin to decline.¹¹

He develops this theory in a lengthy discussion based on data on the "enumerated rural population" of about 50 countries, and an analysis of the historical trend of farm population size in the U.S. He recognizes the theoretical problems associated with the "enumerated rural population," but he fails to test his proposition with data on the agricultural labor force and the farm population, which are readily available.

In our judgment, a better way of showing the relationship between the size of the farm population and socio-economic

¹¹Zelinsky, p. 99.

is based on the definition of urban areas used up to 1950 ("old definition").

Great Britain: The rural population is computed from the following percents of rural population: 1851-1931 (at the decennial census years respectively): 48.8, 45.4, 38.2, 32.1, 28.0, 23.0, 21.9, 20.6, and 20.0; 1951: 19.3. Data were obtained from John Saville, Rural Depopulation in England and Wales 1851-1951 (London, 1957), p. 61.

Sweden: 1900-1950: Historical Statistics of Sweden, Table A-4.

Switzerland: 1880-1950: Annuaire Statistique de la Suisse, 1968, p. 12.

Japan: 1900-1940: Irene B. Taeuber, "Population and Labor Force in the Industrialization of Japan, 1850-1950" in Simon Kuznets et al., eds., Economic Growth: Brazil, India, Japan (Durham, N.C., 1955), pp. 325 and 329. This article gives the following percentage figures for Japan's urban population, which is defined as the population living in places of 10,000 inhabitants or more: 1903 - 20.6; 1908 - 24.9; 1913 - 27.6; 1920 - 32.2; 1930 - 40.8; 1940 - 49.9. By linear interpolation, the estimated proportion for 1900, based on 1903 and 1908, is 18.0%. Similarly the estimated proportion for 1910, based on 1908 and 1913, is 26.0%. 1950: The percent of the population living in places of 10,000+ in 1950 is 54.0, derived from the 1950 census report. (The absolute figures of the rural population derived from the above proportions are shown in Appendix Table I-B, p. 19 below.)

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development is to trace the change in the proportion of the farm population within the rural population. The FARM/RURAL proportions in three selected industrialized countries over a period of several decades are given in Table 4.

Table 4

PERCENT OF FARM POPULATION WITHIN RURAL POPULATION (FARM/RURAL)
IN SELECTED INDUSTRIALIZED COUNTRIES: 1870-1950

Year	(FARM/RURAL) x 100		
	United States	Sweden	Switzerland
1870		83.1	
1880		80.0	
1890		76.5	44.7 ^a
1900		70.1	--
1910	64.2	64.9	36.3
1920	61.3	62.4	--
1930	56.6	58.3	32.6
1940	53.3	54.5	33.0 ^b
1950	42.1	42.8	27.9

^a1888

^b1941

SOURCES: See Table 3 for the sources for the rural population. The sources for the farm population are as follows:

United States: 1910-1940: Historical Statistics of the U.S., Series B-165-170; 1950: Appendix Table V for the FARM/RURAL proportion.

Sweden: 1870-1950: Historical Statistics of Sweden, Table A 21.

Switzerland: 1888-1950: Annuaire Statistique de la Suisse 1968, p. 28.

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The consistent decline of FARM/RURAL proportions shown in Table 4 requires no explanation. The reasons are the same as those given in our earlier discussion of the RURAL/ALF ratios (pp. 8-9), whose upward trend is consistent with the declining trend of the FARM/RURAL ratios, because the ALF is the working sector of the farm population. If the size of the farm population continues to fall with increased economic development, there will be no farm population left in the rural areas of some highly developed countries (e.g., the U.S. and Great Britain). Then the place of residence, whether urban or rural, will be of little or no significance. (In less developed countries, we expect to find that the proportion of the farm population in rural areas fluctuated around 70-75 percent during 1950-1960.)

Some Issues Related to Population/Agricultural Densities

Let us now examine the trend in the size of the agricultural population in relation to arable land in advanced countries. In view of our previous discussion of the trend in the size of the agricultural population (see Tables 1 and 2), we would expect a downward trend in population/agricultural densities. A substantial reduction in the size of the agricultural population alone would reduce densities, even with little or no change in the amount of land under cultivation. As we shall see, however, arable land increases or decreases drastically after a certain stage of agricultural development is reached in a country. (The relevant data are presented in Table 5.)

In the United States, arable land almost doubled during 1850-1890, reflecting the westward expansion across the continent in the nineteenth century. Once this movement was over, the amount of arable land stabilized, but this does not mean that it could not have increased even more. If the demand for produce from arable land had been more than the supply coming from the cultivated arable land, for example, the land under pasture--particularly cultivated pasture--could have been converted into arable land. However, the mechanization of agriculture increased the productivity of arable land, and there was a growing demand for livestock products, characteristic of a rise in income level. We find a continuous increase in pasture areas, from 122 million acres in 1870 to 529 million acres in 1945.¹² Thus a combination of several factors determines the amount of arable land--the demand for agricultural and livestock products, changes in the productivity of arable and pastoral farming, and geographic limitations. We shall pursue these factors further in Chapter IV.

¹²U.S. Bureau of the Census, Historical Statistics of the United States 1789-1945 (Washington, D.C., 1949), Series F-25-36.

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Table 5

ARABLE LAND AND POPULATION/AGRICULTURAL DENSITY IN
SELECTED INDUSTRIALIZED COUNTRIES: 1800-1950

Year	United States		Sweden		Great Britain ^a		Japan	
	Arable land ^b	<u>ALF(B)</u> ARABLE	Arable land ^b	<u>FARM</u> ARABLE	Arable land ^b	<u>ALF(M)</u> ARABLE	Arable land ^b	<u>ALF(B)</u> ARABLE
1800			8.5	218.3				
1810			9.3	210.7				
1820			11.0	194.1				
1830			14.0	169.4				
1840			16.5	153.9				
1850	457.3	10.7	20.3	133.7				
1860	659.6	9.4	25.0	--				
1870	764.8	9.0	25.7	117.4	73.8	22.1		
1880	768.8	11.2	29.5	105.1	70.2	21.6	48.4	304.6
1890	1003.6	9.9	33.1	89.8	65.6	21.7	49.8	296.3
1900	1290.9	8.4	35.6	79.4	63.0	21.2	52.2	276.0
1910	1404.3	8.2	36.9	73.1	59.3	24.2	56.3	254.3
1920	1626.8	7.0	38.7	67.1	60.6	22.7	60.1	228.4
1930	1671.3	6.3	37.6	64.3	51.1	25.7	59.6	230.6
1940	1614.7	5.7	37.2	58.5	60.6	--	54.5	245.2
1950	1643.1	4.5	36.5	44.2	68.3	16.2	52.3	308.4

^aThe data refer to years 1871, 1881, etc.

^bLand areas are in 1000 km².

SOURCES: See Tables 1 and 2 for the statistics on the agricultural labor force (ALF) and the farm population (FARM). The sources for arable land (ARABLE) are as follows:

United States: 1850-1940: Historical Statistics of the U.S., Series F-25-36; 1950: Appendix Table I.

Sweden: 1800-1930: Thomas, p. 93; 1940-1950: Statistiska Centralbyran, Historical Statistics of Sweden; Climate, Land

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The figures concerning agricultural densities in the U.S. show that, during the period of expansion in the nineteenth century, the agricultural labor force increased at almost the same rate as the arable land. Agricultural densities remained at a constant level of about 10 workers per square kilometer of arable land. Since during most of the nineteenth century (particularly prior to 1880), land was in abundant supply in the U.S., the availability of agricultural labor seems to have been the main factor determining the increase of arable land. After 1880 the agricultural density in the U.S. gradually declined. In later decades this was due mainly to a decrease in the agricultural labor force--a decrease resulting in large part from rapid industrial growth, which attracted labor from agriculture.

The trend in agricultural densities in Sweden has been similar to that in the United States. The density declined by more than half during 1870-1950, continuing the pattern set from 1800 to 1860, when the density fell from 218 to 134 persons per square kilometer of arable land.¹³ The picture presented by Great Britain, however, is somewhat different. A continuous

¹³ Dorothy S. Thomas gives an excellent discussion of agricultural developments in Sweden--the transformation from traditional to commercial agriculture (the economic reorganization of agriculture), and the effects of industrialization and the "pull" from America on the growth of the agricultural population--in Social and Economic Aspects of Swedish Population Movements 1750-1933 (New York: The Macmillan Company, 1941), Chapter 2.

Surveying, Agriculture, Forestry, Fisheries, 1955, Vol. II (Stockholm, 1959), p. 28.

Great Britain: The arable lands shown for 1871, 1881, and 1891 actually refer to the periods 1871-75, 1881-85, and 1891-95. 1871-1951: Robin H. Best and J.T. Coppock, The Changing Use of Land in Britain (London, 1962), pp. 234-235.

Japan: 1880-1920: The arable land figures are corrected for concealment in reporting and other errors. The figures are given in chō: 1000 chō = 9.91466 km². Nakamura, sum of areas in Col. (4) in Table 2-8 and in Cols. (1) and (2) in Table 2-10, pp. 43 and 48; 1930: The arable land area is the average for the areas in 1925-29 and 1930-34 (William P. Lockwood, The Economic Development of Japan [Princeton, 1968], p. 86); 1940: The area refers to the arable land reported for 1941. Seiochi Tobata, Japan's Agriculture: Farming Population (Public Information and Cultural Affairs Bureau, Ministry of Foreign Affairs, Japan, 1956), Table 4; 1950: See the country notes for Japan in the Appendix.

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decline in the amount of arable land occurred between 1870 and 1930, due to several internal and external forces. This was the period of colonial expansion into Asia and Africa, making possible the importation of cheap agricultural products from the colonies. At home, the industrial revolution had been in progress for a long time, exerting a steady attraction on labor from agriculture. Farmers engaged in less profitable farming (primarily those with small holdings) could easily migrate to America, to Australia-New Zealand, or to urban areas. Furthermore, as in the U.S., pastoral farming, requiring less labor than arable farming, became increasingly profitable. Statistics provided by Best and Coppock show that the amounts of pasture and arable land in Great Britain were the same in 1920. Since then, the percentage of pasture has fluctuated as follows:¹⁴

<u>Year</u>	<u>Percent of Pasture to Total Agricultural Land</u>
1920	50.7
1924	53.6
1928	56.1
1932	58.4
1936	58.9
1940	54.8
1944	37.6
1948	39.6
1952	41.0
1956	42.4

Throughout the interwar period, the share of pasture increased, but then it began to decline. During World War II, pasture was affected much more than the arable land. The absolute figures show that arable land remained at a level of 17.0-17.9 million square kilometers during 1942-1947, while pasture areas declined appreciably. Since then, pasture has not been able to regain its prewar level. It seems that once there is a diversion from agricultural operations in highly developed countries, due to, for example, large-scale war efforts, it is very difficult for farmers to go back to farming, and for land converted to non-agricultural uses to be put back into agriculture. In any case, agricultural densities in England have been affected by changes in both land and labor. Levels did not change much up to 1930, but since then there has been a definite downward trend--a familiar pattern in industrialized countries.

The changes in agricultural densities in Japan are particularly interesting because, unlike that of Western countries,

¹⁴Robin H. Best and J.T. Coppock, The Changing Use of Land in Britain (London: Faber and Faber, 1962), pp. 234-235.

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Japanese agriculture is labor-intensive. By any standards, agricultural density in Japan is much higher than in Western countries. Although the proportion of the labor force in agriculture declined substantially (see Table 1), the absolute size of the ALF varied only between 14.8 and 13.4 million during 1880-1930. During the same period, arable land increased by about 23 percent, so that the decline in the labor force in agriculture was mainly a function of the change in the amount of land under cultivation.¹⁵

What lessons can we draw from the preceding review of the historical changes in agricultural densities in advanced countries? Obviously, the majority of less developed countries cannot expand their arable land to a magnitude comparable to that in the U.S. Furthermore, the rate of natural increase of population in their rural areas is much higher than it was during the corresponding historical periods of advanced countries. In addition, few less developed countries are experiencing rates of economic growth comparable to those in Japan during 1880-1930. Even if they are, the natural increase in urban areas is likely to fill the additional labor needs created. Thus, on all accounts, agricultural densities in less developed countries are bound to rise. At the same time, we can anticipate finding marked differences in agricultural densities between less developed and advanced countries (with a few exceptions like Japan). Kingsley Davis, among others, has demonstrated that the average agricultural density in advanced countries was less than one-half the average density in less developed countries during 1940-1947.¹⁶ This difference has probably become even greater in 1950-1960 because the density is likely to rise in less developed countries and decline in advanced countries.

¹⁵In this connection, we should note an important aspect in the evolution of the general population. During this period, the growth in the rural labor force due to natural increase had to be absorbed by the non-agricultural sector (and to some extent by emigration to other countries). Among the effects were heavy taxation of the agricultural sector, high population density in the agricultural sector, and the strong pull exerted by industrialization.

¹⁶"Population and Further Spread of Industrial Society," Proceedings of the American Philosophical Society, Vol. 95, No. 1, 1951, pp. 11-12.

Appendix Table I-A
ABSOLUTE FIGURES FOR THE AGRICULTURAL LABOR FORCE USED IN TABLES 1, 2, 3, AND 5
(in 000's)

Year	United States		Sweden	Great Britain ^a		Switzerland	Japan	
	ALF(B) ^b	ALF(M) ^c		ALF(M)	ALF(B)		ALF(B)	ALF(M)
1820	2,069							
1830	2,772							
1840	3,720			1,434				
1850	4,902			1,788				
1860	6,208			1,779				
1870	6,850			1,634				
1880	8,585			1,517			14,742	
1890	9,938			1,422	488 ^d		14,755	
1900	10,912	9,880	720	1,339	--		14,405	
1910	11,592	10,395	758	1,436	477		14,318	
1920	11,449	10,221	808	1,344	--		13,727	7,469
1930	10,472	9,441	799	1,282	413		13,742	7,465
1940	9,162	8,494	688	--	415 ^e		13,363	6,271
1950	7,408	6,352	580	1,105	355		16,132	7,819

^aRefer to years 1841, 1851, etc.

^bALF(B) = Agricultural labor force (both sexes)

^cALF(M) = Agricultural labor force (males)

^d1888

^e1941

SOURCES: Same as for Tables 1, 2, 3, and 5.

Appendix Table I-B
ABSOLUTE FIGURES FOR RURAL AND FARM POPULATIONS USED IN TABLES 1, 3, 4, AND 5

Year	United States		Sweden		Great Britain ^a		Switzerland		Japan	
	Farm	Rural	Farm	Rural	Farm	Rural	Farm	Rural	Farm	Rural
1800			1,856	2,118						
1810			1,960	2,172						
1820		8,945	2,135	2,331						
1830		11,739	2,371	2,607						
1840		15,224	2,539	2,835						
1850		19,648	2,714	3,131		8,749				
1860		25,227	--	3,425		9,109				
1870		28,656	3,017	3,629		8,676				
1880		36,026	3,102	3,875		8,338				
1890		40,841	2,973	3,885		8,121				
1900		45,835	2,828	4,032		7,481	1,108 ^b	2,477 ^b		36,374
1910	32,077	49,973	2,697	4,155		7,899	--	--		36,890
1920	31,614	51,553	2,596	4,161		7,804	1,013	2,795		37,555
1930	30,445	53,820	2,417	4,146		7,990	--	--		37,812
1940	30,547	57,246	2,175	3,990		--	923	2,829		36,342
1950	22,990	60,948	1,612	3,763		8,443	946 ^c	2,863 ^c		38,272
							835	2,995		

^aRefer to years 1851, 1861, etc.

^b1888

^c1941

SOURCES: Same as for Tables 1, 2, 3, and 5.

Chapter II

THE BASIC DATA: SOURCES AND METHODOLOGY

In preparing this study, we collected data under three broad categories: agricultural population, agricultural land, and economic development. The primary aim has been to compile data for two points in time--one around 1950, and the other around 1960--for all the "large" countries and territories in the world.¹ However, figures were compiled even if they were available for only one date. Both national statistical sources (census or survey reports, national statistical yearbooks, etc.) and various international compendia put out by different agencies of the United Nations were used.²

Needless to say, all the basic data reported in this study have been checked and cross-checked. This led to the early rejection of some figures, and particularly affected the coverage in

¹The study is limited to countries and territories having a minimum total area of 5,000 km². The decision not to include countries having areas of less than 5,000 km² is based primarily on methodological grounds. Most such countries are small islands, and the majority of these islands have no history of census operations or other methods of data collection. Had such countries been included in our analysis, the analytical difficulties would have been greatly compounded by the lack of data for a sizable proportion of the countries under consideration. The total number of countries and territories of all sizes in 1960 is 214, and the number of "large" countries--i.e., with areas of 5,000+ km²--is 156. Our listing of these 156 countries follows that used in Kingsley Davis, World Urbanization 1950-1970, Volume I: Basic Data for Cities, Countries, and Regions (Berkeley: University of California, Institute of International Studies, 1969; Population Monograph Series, No. 4).

²Many precautions must be taken in using the data from these various compendia. See Davis's comments in World Urbanization, Vol. I, p. 4, and in "Problems and Solutions in International Comparison for Social Science Purposes" (Berkeley: University of California, Institute of International Studies, 1968; Population Reprint Series, No. 273; originally published in Spanish in América Latina, January-March, 1965).

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regions such as Africa and Western Asia. In spite of all precautions, we had to reject still more figures during the subsequent analysis because they produced highly improbable rates or ratios.

Data on Agricultural Populations

Data were collected on three overlapping groups associated with agricultural industry: (1) the agricultural labor force, specifically the economically active males in agriculture; (2) the farm population; and (3) the rural population. The definitions, problems, and methods of adjustment for statistical coverage of the three groups are discussed in the sections which follow.

The Agricultural Labor Force

Data on the agricultural labor force are restricted to males because there is no consistent treatment from one country to another of females who perform the dual role of housewife and agricultural worker.³ The contribution of females to agriculture is substantial, particularly in less developed countries; it roughly parallels that of males. For the sake of comparability, however, it was decided to exclude females from the labor force data.

It is well known that comparisons between countries with respect to the total economically active population and the industrial and occupational distribution of the population are difficult because various groups are likely to be treated differently in the statistics of the different countries, particularly unpaid family workers (mostly females), members of the armed forces, inmates of institutions, seasonal workers, and part-time workers.⁴

³The examples given below illustrate the problem. Each pair of countries belongs to the same geographic subregion, but the sex-ratios (males/females) of the labor force in agriculture are specified as follows:

Tunisia (1956)	1.62	U.A.R. (1960)	27.50
Bechuanaland (1964)	0.91	South Africa (1960)	9.89
Brazil (1960)	10.20	Colombia (1964)	19.67
South Korea (1960)	2.28	Japan (1960)	0.94
Iran (1956)	19.90	Turkey (1960)	0.93
France (1962)	2.05	West Germany (1961)	0.83
Spain (1960)	11.79	Yugoslavia (1961)	1.37

⁴See United Nations, Handbook of Population Census Methods, Vol. II, Economic Characteristics of the Population, 1st/Stat/Ser. F-15/Rev. 1) (New York, 1958).

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We have not attempted to adjust the figures for the total economically active population or the agricultural population to allow for differences in the statistical treatment of these groups, because such adjustments seem unnecessary in view of the aims of our analysis. We are more interested in the size of the agricultural labor force than in the makeup of the total labor force. If groups such as the armed forces and inmates of institutions are treated differently in the different countries, the comparability of agricultural labor forces will not be significantly affected. The total labor force data are needed primarily to compute the proportion of the labor force in agriculture. Therefore, the effect of the incomparability of some occupational groups would be minimal.

On the other hand, serious efforts have been made to standardize the minimum age in definitions of "economically active populations" or "labor force." If the minimum age was something other than 14 or 15 years, we adjusted to find the total labor force and agricultural labor force for ages 15+ years. Generally, for the countries that needed adjustments, the age-distribution of the total labor force was available, but not for the various occupation groups. The agricultural labor force for ages 15+ years was obtained by assuming the identical age-distributions for the total labor force and the agricultural labor force. This assumption is justified because such situations usually arise in countries where the agricultural occupations dominate the labor force.

Depending on the availability of data on age-distribution versus occupations, other procedures were used. For example, if the age-distribution for 1960 was available but not for 1950, the 1960 age-distribution was used to estimate the labor force for ages 15+ years. If none of the age-distribution data were available and the minimum age in the labor force definition was other than 14 or 15 years, an interpolation method or the age-distribution of a neighboring country was used. (The procedures used are discussed in the Appendix.)

We tried to collect data for the agricultural "occupations" rather than for the agricultural "industry" because our aim is to determine the labor force that derives its livelihood directly from agricultural activities. About 15 countries have data for neither 1950 nor 1960. There are about 20 countries that have "industry status" data for both census years but "occupation status" data for only one (usually 1960). In such cases, the ratio of the labor force in agricultural industry to that in agricultural occupations in one census year was used to estimate the labor force in agricultural occupations in the other census year.

[After completing all the adjustments required to get data on "agricultural occupations," my conclusion is that it is

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not worth the effort, for several reasons. First, the difference between the labor force in agriculture as an "occupation" and that in agriculture as an "industry" is only 5 percent at most (excluding the United Kingdom). Second, the distinction between agricultural occupation and industry is almost meaningless in the less developed countries, though it may be significant in countries where agriculture is highly mechanized. As a consequence, the less developed countries do not attribute much importance to tabulations of the agricultural labor force by occupational status. The figures for the following countries, selected from different regions, show that the labor forces in "agricultural industry" and in "agricultural occupations" are almost the same in magnitude:⁵

Country	Year	Ratio: <u>Agricultural Industry</u> <u>Agricultural Occupations</u> (Males)
U.A.R.	1960	1.0047
South Africa	1960	0.9968
U.S.	1960	1.0501
Ecuador	1962	1.0015
India	1961	0.9993
Switzerland	1960	0.9778
U.K.	1961	0.8640
Japan	1965	1.0069

These ratios provide the rationale for one of our procedures: When agricultural occupation data were not available for either 1950 or 1960, we substituted the agricultural industry data on the labor force. In sum, our overall analysis would not have been substantially affected if we had made no attempt to obtain "agricultural occupation" data, and had used the "industry" data only throughout the analysis.]

Adjustments for the Uniform Reference Years. To obtain the labor force data for the common reference years, 1950 and 1960, we used a different method of estimation for each of the different situations we encountered:

(1) For the 17 countries where census years coincide with both common reference years, no adjustments were necessary.

(2) For the 48 countries where the data exist for two census years, but one or both years are different from the reference years, the data for the reference years were estimated by using the observed intercensal exponential growth rates of the total/agricultural labor force.

⁵Source: International Labour Office, Yearbook of Labour Statistics 1967 (Geneva), Tables 2A and 2B.

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(3) For the 35 countries where the data are available for only one census year, and that census year is different from either reference year, the rate of growth of the total population was used to estimate the total economically active population at the nearest reference year. Then, to get the agricultural labor force for the reference year, the estimated total labor force was multiplied by the proportion of the labor force in agriculture for the census year.

The remaining 56 countries have no data and were excluded from the analysis. Thus, of the 156 countries of the required size (5,000+ km² in area), 100 constitute our sample.

Farm Population

By adding dependents to earners in agriculture, we get a component of the total population that can be called "farm population." There are two types of sources of data on the farm population: agricultural censuses and population censuses.

Farm populations obtained from agricultural and population censuses are not necessarily comparable. The difference stems from the nature of the basic unit of data in the two types of censuses. Generally, land (legal or physical ownership) is the basic unit in an agricultural census, whereas the basic unit in a population census is a household. In an agricultural census, farm population is usually defined as all the members of farmers' households or all persons "living permanently on an agricultural holding." Thus the size of the farm population depends on the definitions of household and agricultural holding. A household is usually defined as the head of household, his family, and all other persons sharing the same kitchen; an agricultural holding is generally defined as land used wholly or partly for agricultural production. Of course, all countries do not employ the same definition for agricultural holding, but essentially it denotes a piece of land devoted to agricultural production, including activities associated with livestock. The holders, by definition, are owners of land. Landless agricultural laborers and their dependents are excluded from the farm population in a typical agricultural census. Only those agricultural laborers and their dependents who live permanently on an agricultural holding are included in the farm population.

In a population census, the farm population is commonly defined as all members of households whose head is engaged in agriculture. The head of a household need not be an owner of land.

Theoretically, the farm population obtained through a population census should be larger than the one obtained through

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an agricultural census. The difference would be mainly the function of the number and average size of households of landless, migrant agricultural laborers. (This could lead to errors in calculation and estimation, of course, in the few countries where the farm population is obtained from an agricultural census only.) Some empirical evidence of this difference can be obtained from countries where both types of censuses of the farm population were tabulated at about the same time. We have come across three such cases, given below:⁶

Country	Census	Farm Population (000's)
Colombia	Population census, 1964	8,073
	(Estimate in 1960) ⁷	(7,138)
	Agricultural census, 1960	6,556
Austria	Population census, 1960	1,155
	Agricultural census, 1960	875
South Korea	Population census, 1960 (Dec. 31)	14,165
	Agricultural census, 1960 (Feb. 1)	14,243

As anticipated, there are significant differences between the two farm populations in the censuses for Colombia and Austria. However, they are virtually identical in the censuses for South Korea--something for which we have no sure explanation.

Our definition of farm population follows the concept used in population censuses. Therefore we have given priority to population censuses in collecting data on farm populations. If, in a particular country, an agricultural census is the only source of data on the farm population, we have used this agricultural census, but have taken into account the bias of the source in interpreting the results of our analysis of the farm population.

The Food and Agriculture Organization of the United Nations (FAO) has published two of three projected volumes of the Report on the 1960 World Census of Agriculture Programs (see

⁶ Sources: Agricultural censuses: Food and Agriculture Organization of the United Nations (FAO), Report on the 1960 World Census of Agriculture Programs, Census Results by Countries, Vol. 1/a (1966) and 1/b (1967) (Rome). Population censuses: see Appendix.

⁷ Obtained by using annual exponential growth rate of .0308 of the total population observed during 1950-60.

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footnote 6 above) and the complete set of the Report on the 1950 World Census of Agriculture Programs. These publications contain details of definitions and a wide variety of data in a standard format for each country participating in the census program. The FAO also includes a table on the farm population in its Production Yearbooks. These are useful for cross-checking, but they are not always explicit about sources. Figures may be based on agricultural or population censuses, or they may be estimates. Up to 1965, the FAO published actual figures on the farm populations for specific years (generally census years) for different countries. However, since 1966 the Production Yearbooks have contained a table of estimates of farm populations for a common year (e.g., 1965) for all the countries. This has extended the coverage, but unfortunately the methods of estimation for individual countries are not given. In about 25 countries, the 1965 estimates of the farm population shown in PYB 1967 are highly inconsistent with earlier census results. We have accepted only those estimates of farm population given in the Production Yearbooks that are consistent with other available evidence, such as its relative size with respect to rural population, agricultural labor force, or a previously enumerated farm population.

Generally, in the case of population censuses, we collected the data from national sources. Of 75 countries having data for the period around 1960, population censuses were available for 22 countries, agricultural censuses were the only source available for 31 countries, and estimates from PYBs had to be used for the remaining 22 countries. (The sources of PYB "estimates" may well be censuses, but with respect to the 22 countries cited here, they have been labeled "estimates" because it has been impossible to trace the original sources.)

Adjustment for the Uniform Reference Years. (1) If the farm populations were available for two census years and if one or both differed from the common reference years (1950 and 1960), the data for the reference years were estimated by using the intercensal exponential growth rate of the farm population. (2) If the farm population was available for only one census year, the data for the nearest reference year were estimated by using the exponential rate of growth of the rural population during 1950-60.

Rural and Total Populations

The data concerning rural populations and total populations were provided by the International Population and Urban Research center.⁸ The rural population figures are derived from

⁸These data have been published in Davis, World Urbanization, Vol. I, Table A. Since the publication of this monograph, some

the total and urban populations, which were the data directly ascertained by IPUR. Since the rural population is a "derived" figure, its accuracy is obviously dependent on the accuracy of the total and the urban populations.⁹ Davis warns us about the potentiality of a great error in calculating the rural population when both the urban and total populations are in error in opposite directions. He cites a hypothetical example:

If, for instance, the total population of a country were really 150,000, and the urban population were 100,000, the rural population would be 50,000. Now, if the reported total population were 10 percent less, and the urban population were 10 percent more, the algebraic sum of the two relative errors would be -20 percent. But the relative error in the rural population figure is not -20 percent but -50 percent.¹⁰

If this example is close to the actual situation in any country, the error in the estimation of rural population would be very serious. It may be helpful to examine the interrelationships between the errors in the following manner:

Let T, U, and R be the actual total, urban, and rural populations; and t, u, and r the respective enumerated populations. If the errors in the reported figures are expressed as

$$x = \frac{t}{T}, \quad y = \frac{u}{U}, \quad z = \frac{r}{R}$$

then, since $t = r + u$

it can be shown that

$$z = \frac{x - y}{a} + y \tag{1}$$

= relative error in the rural population where

$$a = \frac{R}{T} = \text{proportion of the rural population.}^{11}$$

new data have been published. Accordingly, we have revised the estimates for Swaziland, Lesotho, Upper Volta, Colombia, and Japan.

⁹Ibid., p. 40.

¹⁰Ibid., p. 40.

¹¹Here "a" is based on the actual figures. If "a" is defined in terms of the reported figures, that is,

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In the Davis example we have: $a = 0.33$, $x = 0.90$, $y = 1.10$. So,

$$z = \frac{.9 - 1.1}{.33} + 1.1 = .50 ,$$

or the rural population is underestimated by 50 percent. Equation (1) shows that "a" is a crucial variable. Thus, in the above example, if "a" were taken as 0.90, "z" would be 0.88. Fortunately, the combination of x less than one (total population underestimated) and y more than one (urban population overestimated) occurs most often in countries that have a very high proportion of rural population--i.e., "a." In such cases, as noted above, "z" tends to unity.

Data on Agricultural Areas

Data were collected concerning two broad categories of land utilization--arable land and pasture--and some subgroups of these categories, to be discussed later in this section. The areas in each category are the net areas; areas cultivated more than once a year were counted only once. Agricultural censuses deal with net areas, but "estimates" may not be so confined. Careful checks were made to ensure that no gross areas are included. Generally, the gross areas are termed "cropped areas" or "cropland."

Unlike the case of population data, censuses are not the only reliable sources of data on agricultural areas (particularly arable areas). Other sources are historical records, government "estimates," and revenue records. In most old civilizations, land records have been kept for a long time. Increases in the size of population result in a greater necessity for legal land titles; these require measurement of almost all the land in use, particularly arable land. In India, for example, statistics on cultivated areas have been maintained for centuries through an extensive bureaucratic system. As early as the sixteenth century

$$a = \frac{r}{t} ,$$

then a similar expression for "z" would be obtained as

$$z = \frac{x - y}{a} + y$$

where the relative errors are defined in the inverse form, e.g.,

$$x = \frac{T}{t} , \quad y = \frac{U}{u} , \quad z = \frac{R}{r} .$$

a large part of India was covered in a plot-by-plot land measurement scheme. In Israel, the government "estimate" of arable land may be more reliable than the figure obtained through an agricultural census in another country. Similarly, the estimated arable area in Saudi Arabia ($3,300 \text{ km}^2$) is probably fairly accurate, though the country's estimated total area was in error for a long time.¹² In West Pakistan, revenue records showed the net sown area in 1960 as $32,110 \times 10^3$ acres, compared to a figure of $32,011 \times 10^3$ produced by the first agricultural census (1960), based on a 20 percent sample of the villages. The matching could not have been much better.¹³

Nature of the Sources

In the section on farm population, we described the FAO's publications on the 1950 and 1960 world agricultural census programs. So far, in the 1960 program, the data on 50 countries have been published. These reports were very useful in the collection of our data, and since they give complete citations of original sources, they helped us to find basic documents. In addition, the FAO's Production Yearbooks contain a table on land utilization.¹⁴ A general note to the table states that with few exceptions all the figures are based on official statistics. We tried to trace the original source for each country to find out whether the data are based on an agricultural census or survey. We found that around 1960 the data on agricultural areas for 56 countries are definitely based on agricultural censuses or surveys. The data for the 67 other countries in Appendix Table I are considered by

¹²Until 1962 the Demographic Yearbook listed the total area of Saudi Arabia as 1.6 million km^2 ; after that, a figure of 2.1 million was used. According to the Statesman's Yearbook 1965, the earlier estimate was not based on scientific methods.

¹³However, in East Pakistan there was some disparity in the results from the census and the revenue records: they showed areas of $18,848 \times 10^3$ and $20,848 \times 10^3$ acres respectively. One reason for the discrepancy in East Pakistan may be that the agricultural census was based on only a 10 percent sample of villages, compared to the 20 percent sample in West Pakistan. (Sources: Agriculture Census Organization, Pakistan Census of Agriculture, Vol. I, Final Report, East Pakistan, p. 114; Vol. II, West Pakistan, 1964, p. 112; Central Statistical Office, Statistical Yearbook, 1964, Pakistan, p. 94).

¹⁴The coverage in this series has improved considerably in recent years.

us to be only "estimates," whether the source is a PYB or another national statistical source.¹⁵

Land-Utilization Classification

The term "agricultural land" means the land usually devoted to agricultural production. We have deliberately employed the word "usually," for it takes into account an important fact concerning agricultural practices--viz., an optimum agricultural production plan does not imply that all the land is used all the time. Under most farming conditions, in order to retain or regain the fertility of cultivated land, the cultivator must leave the land idle for one or two seasons--i.e., he must let it lie fallow. However, the process of regaining soil fertility can be hastened by artificial methods, such as the use of fertilizers and the planting of soil-improvement crops.

Pasture is an important component of agricultural land. Since the products supplied by livestock, such as milk, meat, hides, wool, etc., are commodities in "agricultural production," the land used for grazing is included in the statistics on agricultural land.

As far as arable land and pasture are concerned, there seems to be no difficulty in classifying them as agricultural. But what about the land in forests? Forests are usually regarded as a source of fuel and building materials. Some parts of forest land, such as those in "national forests," are banned to agricultural uses. Forests are not "planted" or "harvested"; hence they use very little manpower. In this sense they are akin to uncultivated pastures. The basic difference between forest and uncultivated pasture is that the latter is used for domestic cattle but the former may be totally unused. For this reason we shall not include forests in agricultural land.

For our purposes, agricultural land consists of two main components: arable land and pasture. We shall now discuss the problems involved in obtaining data on these two kinds of land.

The ideal, of course, would be to have standard definitions for these two components so that the data concerning them could be processed in the same way for all our countries; however,

¹⁵ National sources were checked primarily to get more detailed data on land utilization (e.g., on fallow land and cultivated pasture) than that shown in the PYBs. The statistical publications of the Pan American Union were very useful for the American countries.

this is virtually impossible. There are as many variations in the definitions as there are countries. By and large, our approach has been to accept the national definition if it is not radically different from all the others. Generally there is a sound logic in a national definition that allows for special local conditions. For example, there is no point in defining the fallow land in India as "the land lying idle for the preceding five years," because the land is commonly left idle for only about one to two years. For reasons such as this, the FAO, while giving guidelines to individual countries in their conduct of agricultural censuses, was not very strict about international definitions of the components of agricultural areas.

Arable Land. In agricultural census reports, data on arable land are classified in several ways. The manner of classification depends on agricultural practices, the purpose of the census, the experience of the country in conducting agricultural censuses, etc. However, there are a few broad categories of arable land that are commonly used in land statistics. These are: land under temporary crops, land under permanent crops, fallow land, and temporary meadows and pasture. Of these we are particularly interested in the proportion of fallow land relative to the total arable land. (The importance of fallow land will be discussed in Chapter IV. It is one of the two categories included in our tabulations on arable land shown in Appendix Table I.)

The period of crop rotation determines the terminology applicable to the crop area. If the period of rotation is less than a year, the crop areas are called temporary (e.g., fields of wheat, maize, and barley); otherwise they are known as permanent crop areas (e.g., orchards, vineyards, and nurseries).

The definition of fallow land varies according to agricultural practices. In countries like Taiwan and Vietnam, fallow land is not even mentioned in the definition of arable land. In India and Pakistan it denotes the land which is not cropped during the census year but harvested during the preceding year; the cultivated land lying idle for more than one year is termed "culturable waste." In Western European countries the practice of having fallow land is not in vogue. Nevertheless, fallow land is separately classified, but generally its definition does not specify any time limit. On the other hand, the practice of having fallow land is common in American countries. Obviously the specification of a time limit in the definition of fallow land will have an important bearing on the amount of such land reported. In American countries, land lying idle for as many as five years can be termed fallow. Some American countries have vague time limits: Colombia is an important example. Its definition reads:

Fallow land includes the land resting for a period of time before it is planted again. It also includes...

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arable land damaged by floods, land prepared for cultivation but not sown on account of unforeseen circumstances, crop failures, etc.¹⁶

The extent of fallow land may depend not only on the time limit, but also on the season or the particular year in which a census is taken.¹⁷ For example, in a year of severe crop failure the proportion of fallow land would increase.

In sum, it is clear that there are many variations in the definitions of fallow land. As indicated earlier, we have generally accepted the national definitions.

The fourth and final category of arable land to be discussed here is "temporary meadows and pasture." This denotes land that is generally used to grow temporary crops but is being used temporarily as pasture or meadows. The definitions vary according to the time limits for the use of land as pasture, beyond which the land would be regarded as "permanent pasture." The dividing line may not be clearly established (e.g., the definition used by the United States); the time limit of five years is rather common in the Latin American countries.

To conclude this section, it would perhaps be instructive to reproduce the extensive description of arable land given in the 1960 U.S. Census of Agriculture:

This includes land from which crops were harvested; hay (including wild hay) was cut; and land with small fruit orchards, vineyards, nurseries and greenhouses. Under this category is also included all land used only for

¹⁶FAO, Report on the 1960 World Census of Agriculture Programs, Vol. 1/a, p. 60. Perhaps this broad definition explains the high proportion of fallow land. In 1960 the areas under temporary crops and fallow land were 19,530 km² and 15,790 km² respectively.

¹⁷An extreme example is the 1950 sample census of agriculture in Bolivia, which showed 24,372 km² of fallow land in contrast to cultivated land of 6,543 km². The definition of fallow land was very broad--i.e., "the land, which is generally cultivated, lying idle." The census covered only about 30 percent of the total area. Because of this, and the unusually high proportion of fallow land, we excluded the data from our collection. The reason for the large area under "fallow" may be that the census was conducted some time after the main harvest period. (Source: Director National de Estadística y Censos, Censo Agropecuario 1950, p. viii and Tables 4 and 5).

pasture or grazing that could have been used for crops without additional improvement, and all land planted to crops that were pastured or grazed before reaching maturity, or on which swine were released to harvest the crop (hogged off). Cropland also includes cultivated summer fallow, land used only for soil-improvement crops, land on which crops failed, land planted to crops for harvest after the year covered by the census and land which had been plowed and could be plowed again without first clearing away the brush, but which had been idle for one or more years.

Land from which two or more crops were harvested to be counted only once. In reporting land in his holding according to the use made of it during the census year, the holder was asked to differentiate between some classes of land for which the dividing line was not always clear and could not always be determined on a uniform basis. For instance, permanent pasture may have been included either under "cropland" or "permanent meadows and pastures," depending on whether the enumerator or holder considered it as cropland or not.¹⁸

Pasture. Pasture consists of either cultivated or natural pasture. As the name implies, cultivated pasture (permanent) refers to land devoted to herbaceous forage crops that are sown and cared for like other crops. Natural or uncultivated pasture is grassland not being improved through human effort. This is one of the most uncertain components in the domain of agricultural land. Grasslands can vary in density and quality--from sparse to dense grasslands. The area classified under natural pasture seems to be independent of the intensity of its usage. Sometimes the land referred to as permanent pasture includes areas with ambiguous use (e.g., "rough grazing" and "waste land"). We did not include such areas in our classification. (Paraguay, Saudi Arabia, and the Federation of South Arabia are examples of places where a large proportion of the total area is shown as "rough grazing.")¹⁹ The quality and extent of reporting of pasture seems to be dependent on the importance of pasture activities in a country's economy.

In the collection of data on pasture, our main guidelines were as follows: (1) The data were rejected if they were clearly unreliable (e.g., as stated above, the land under rough grazing

¹⁸FAO, Report on the 1960 World Census of Agriculture Programs, Vol. 1/a, p. 200.

¹⁹See FAO, Production Yearbook 1965, Table 1.

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and "waste land"). (2) Pasture is listed in two categories: cultivated pasture and total pasture. Cultivated pasture is shown separately only if a specific definition of cultivated pasture is available in national or FAO census reports. If the cultivated pasture is not clearly identified, we show the available pasture area as "total pasture" only. (A frequent example of this situation is when the source was an FAO Production Yearbook, where pasture is shown under the heading of "permanent meadows and pastures.")

In our collection there are more countries with data on arable land (123 in 1960) than with data on pasture (88 in 1960). One reason for this is the unreliability of pasture figures.

Adjustment of the Agricultural Land Data for the Uniform Reference Years. If land areas are available for two dates, and if one or both differ from the reference years, the data for the reference years were estimated by using the straight line interpolation/extrapolation method. If, on the other hand, a land area is available for only one year, the same area was assumed for the nearest reference year (e.g., the arable area reported by the 1962 census was assumed for the year 1960).

Measure of Economic Development

We need a measure of economic development so that countries can be divided into four or five groups representing different stages of economic growth. Per capita income has often been used for this purpose, but there are problems in using national income figures. In less developed countries, the contribution of the agricultural sector to the national income is difficult to measure accurately because all the agricultural products may not pass through modern market channels. It so happens that the majority of the world's population lives in countries where the agricultural sector is the dominant one. This is not to suggest that there are no problems of income measurement in the non-agricultural sector of the less developed countries, but only that the principal ones are in the agricultural sector.

Further, there are variations in national accounting systems. The comparative magnitude of a nation's income may depend on the exchange rates between currencies, which may not correctly reflect the comparative economic situations. (The exchange rate between the French and the West German currencies prior to 1969 is an example.)²⁰ These and other criticisms of per capita income

²⁰ The franc was devalued by 12.5 percent in 1969.

should not be taken to mean that it is a useless measure.²¹ In my opinion, no single measure can serve as an adequate indicator of economic development.

Per Capita Electricity Production as a Measure of Economic Development

For the classification of countries into a few economic groups, we needed a characteristic that is closely linked to economic level, that has few methodological problems and biases in measurement, and that has a wide coverage. After some preliminary trials we decided that the per capita electricity production would serve our purpose well.

The role of electricity in economic development needs no elaboration; the following quotation is a typical description of its importance:

Electricity constitutes an advanced stage of energy utilization, the development of which is a prerequisite for economic and social progress. The development of electricity has made it possible not only to take advantage much more intensely of some renewable sources like water, but it has also created a number of new uses for all kinds of energy in the production and social process. Industrial development, mechanization and urban progress are virtually a function of electricity supplies. Therefore, consumption of electricity is a very significant indicator both as a means of appraising the specific energy situation and the general state of the countries.²²

²¹This is only a layman's description of the problems associated with per capita income. For a professional evaluation of the measure and other related problems, see Harvey Leibenstein, Economic Backwardness and Economic Growth (2nd ed.; New York: John Wiley and Sons, Inc., 1957), Chapter 2. However, Leibenstein accepts per capita output as an "index of development." One of his arguments is that "we cannot take a perfectionist view" in choosing an index for a concept like economic development. But we must try to minimize the biases. For an account of the problems of comparative statistics on the national income, see United Nations, Statistical Yearbook 1967, "General Note and Footnotes to Tables 185 and 186," p. 581.

²²Economic Commission for Latin America (ECLA), Energy in Latin America (Geneva: United Nations, Department of Economic and Social Affairs (E/CN.12/384/Rev.1), 1957), p. 30.

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The data on electricity production are quite reliable. Electricity figures are free from the main methodological problems associated with national income figures. In addition, as we shall show in the next section, the coverage of the data is extremely good. However, the electricity data are not completely free of biases. Other things being equal, a country with a higher potential of electricity production could of course produce more electricity than another one. For instance, Norway has the highest per capita electricity production in 1960. This could be partly because of a very high hydroelectric potential in Norway. To cite another example: As pointed out in the ECLA study cited in footnote 22 below, electricity production has become increasingly important (over time) in comparison to other forms of energy in Latin America because of a combination of abundant water-power resources and a relatively short supply of fossil fuels. In spite of such factors, we find very few "deviant" cases, and on the whole the measure of electricity production is consistent with other known evidences of economic development. On the basis of data for 68 countries, the correlation coefficient between per capita electricity production and per capita steel consumption in 1963 was 0.734,²³ and there was a correlation coefficient of 0.904, based on data for 55 countries, between per capita consumption of electricity and the gross per capita product (dollars at 1950 prices) during the period 1955-58.²⁴

The main sources of data on electricity production are the statistical yearbooks of the United Nations and publications of the regional United Nations agencies. National sources were used in a very few cases. Since there could be abrupt changes in the annual production figures, wherever possible we used five-year averages centering on 1950 and 1960. If it was not possible to do this, three-year averages were computed. Lacking either of these, two-year averages or the nearest single-year production figures were used--e.g., for 1960 we used the figures for 1959-60, 1961, 1959, etc., depending on the availability of data. In this respect, the data for 1960 are very good. Of the total of 138 countries considered, five-year averages (1958-62) were used for 127 countries, and three-year averages (1959-61) for two countries. The figures for the remaining nine countries were obtained in varied ways.

²³ Computed from United Nations, Statistical Yearbook 1967, Tables 17, 144, and 168.

²⁴ United Nations, Estudios sobre la electricidad en América Latina (Mexico, D.F., October 1962), E/CN.12/630, p. 75.

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Classification of the Countries According to Economic Levels

We used the 1960 rather than the 1950 electricity production figures in our classification system because of their better coverage. To divide the countries into five economic groups, we used the logarithms of the per capita electricity production in KWH--log(EP)--as the stratification variable. This is because logs(EP) follow the normal distribution. The normal area curve can then easily be divided into five equal parts. The data that follow show the results.

The following central moments and the mean refer to the variable log(EP):

Year	Number of Countries	μ_2	μ_3	μ_4	Mean
1950	109	4.5041	-2.1067	47.7761	4.164
1960	138	4.2094	-0.5118	39.7891	4.831

The test for normality can be performed by computing the coefficient of skewness, r_1 , and coefficient of kurtosis or excess, r_2 . For the normal curve, their values should be zero, that is,

$$r_1 = \frac{\mu_3}{\sigma^3} = 0$$

$$r_2 = \frac{\mu_4}{\sigma^4} - 3 = 0$$

In the present case of log(EP), the values are

	r_1	r_2
1950	-.2204	-.6450
1960	-.0592	-.7545

This shows that the distribution in 1960 is almost symmetrical (skewness is zero), and the coefficient of kurtosis is not far from that of the normal distribution. Thus the distribution of log(EP) in 1960 is quite close to the normal.

The four dividing points for the five economic regions would be the abscissas of the normal curve that divide the curve into five equal parts. The results are:

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Area in the Standard Curve (= $\frac{1}{\sqrt{2\pi}} \int_{-\infty}^x e^{-x^2/2} dx $)	Absicca X	Value of Log(EP) $x = \sigma X + \bar{x}$
0.8	0.85	6.5752
0.6	0.26	5.3645
0.4	-0.26	4.2975
0.2	-0.85	3.0868

Therefore we can set up the intervals as follows:

Economic Level	Log(EP) 1960	EP = <u>Electricity Production in KWH</u> 1960	Total Population
1 (Lowest)	0 - 3.0868		0-
2	3.0869 - 4.2975		21.92-
3	4.2976 - 5.3645		73.52-
4	5.3646 - 6.5752		213.69-
5 (Highest)	6.5753+		717.10+

The Coverage of the Basic Data

In the preceding sections, our data have been discussed in terms of number of countries, type of source, and method of adjustment, if any. But the number of countries does not indicate the proportion of the total world population living in these countries. In this section we will summarize the population distribution of the countries according to the coverage of our basic data.

In population distributions such as those shown in Table 6, the availability of data on the giant populations of China and India exerts a great influence. Thus the percentage of the population in countries with data for both 1950 and 1960 is larger for the farm population than for the labor force, even though the number of countries is larger for the latter. The population of China is responsible for this situation. Table 6 shows that more than 97 percent of the world's population (living in countries with total areas of 5,000+ km²) is covered by our data for 1960 on arable land and electricity production. The greatest improvement in the coverage of data from 1950 to 1960 is shown in the labor force data, which reflect new population censuses around 1960. The coverage of the labor force data is discouraging, however, for only half of the world population is covered in both reference years. This means we cannot get growth rates for the agricultural labor force for one-half of the world's population.

The data on agricultural areas in terms of the distribution of the total area of the countries is given in Table 7. Among the

Table 6

NUMBER AND POPULATION DISTRIBUTION OF COUNTRIES ACCORDING
TO THE COVERAGE OF THE BASIC DATA

Data Exist for	Labor Force		Farm Population		Arable Land		Electricity Production	
	Number of Countries	Population Distribution ^a	Number of Countries	Population Distribution ^a	Number of Countries	Population Distribution ^a	Number of Countries	Population Distribution ^a
1950	65	52.76	44	70.64	88	86.79	108	95.78
Yes	Yes							
No	Yes	14.22	31	6.50	35	10.08	30	3.74
Yes	No	2.70	7	0.25	6	0.44	1	0.02
No	No	30.32	74	22.60	27	2.70	17	0.46
<u>Totals</u>	156	100.00	156	100.00	156	100.00	156	100.00

^aPercent of the total world population living in the countries in the four categories as measured in 1960.

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countries having no data at all, proportionally more of the physical area (9.0 percent) of the world is involved than of the population (2.7 percent).

Table 7

NUMBER AND AREAL DISTRIBUTION OF COUNTRIES ACCORDING TO THE COVERAGE OF THE AGRICULTURAL AREAS

Data Exist for		Arable Area		Total Agricultural Area (Arable + Pasture)	
1950	1960	Number of Countries	Population Distribution ^a	Number of Countries	Population Distribution ^a
Yes	Yes	88	73.26	57	35.57
No	Yes	35	17.07	31	29.87
Yes	No	6	0.65	9	8.64
No	No	27	9.01	59	25.92
<u>Totals</u>		156	100.00	156	100.00

^a Percent of the total world area of the countries in the four categories.

Chapter III

CHANGES IN THE AGRICULTURAL POPULATION AND LABOR FORCE

The analysis in this chapter is of the variations in the three measures of agricultural population--the male agricultural labor force, the rural population, and the farm population--according to economic levels and geographical regions. For convenience the analysis is divided into three parts:

(1) A study of the relative size of the agricultural population--for example, the proportions of the rural population to the total population and to the labor force in agriculture;

(2) A study of interrelationships of the different measures of the agricultural population (the ratio of the farm population to the rural population, the ratio of the rural population to the agricultural labor force, etc.);

(3) A study of the rates of growth of the agricultural labor force, the rural population, and the farm population during 1950-60.

Classification of Countries into Broad Groups

In a comparative study such as this, it is difficult to comprehend the results unless the countries are arranged in a few broad groups. The criteria used for grouping should have substantive significance, so that the variations, if any, of summary measures by groups can be put into a theoretical framework. The number of groups depends on the nature of the statistical analyses to be performed. Most of the common statistical tests and sampling measures require that the sample size be approximately 20 or more. Therefore, if we divide our universe of 156 countries into four or five broad groups, we can reasonably expect to find in each group a sufficient number of countries for which data are available for a given characteristic.

We shall use two kinds of groupings. In the first, the countries are grouped into four categories according to stages of economic growth. In the second, the countries are grouped into five geographic regions--viz., Africa, the Middle East, Asia, the "Frontier Countries," and Europe. Since these regions are very heterogeneous with regard to agricultural populations and agricultural lands, the summary measures may conceal some important

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differences. For this reason the countries are grouped into 22 subregions as well. Consequently, the sample size is bound to become very small. Therefore, analysis like the regression analysis cannot be performed for subregions; we will merely compute the weighted means of various characteristics.

Classification of Countries According to Economic Levels

In the preceding chapter we described the procedure of dividing the countries according to five economic levels. The distribution of the countries is as follows:

<u>Economic Level</u>	<u>Number of Countries</u>
1 (Lowest)	31
2	24
3	26
4	27
5 (Highest)	<u>30</u>
	138

The remaining 18 countries ($156 - 138 = 18$) could not be classified because electricity production data for 1960 were not available. The coverage for other types of data in these countries is almost as bad. It seems likely that the main reason for the lack of data for most of these countries is that they are economically poor; accordingly they can be classified as belonging to economic level 1.

After some preliminary analysis, we reclassified the countries into four economic groups. Economic levels 2 and 3 were merged into one group primarily for two reasons. First, the coverage of data for some crucial variables was quite poor in these two groups, particularly for 1950. For example, for 1950 it was possible to compute the agricultural density (ratio of agricultural labor force to arable land) for only eight and ten countries in economic levels 2 and 3 respectively, while this density could be computed for 15 and 25 countries in levels 4 and 5 respectively. Therefore, if we merged economic levels 2 and 3,

¹A look at the list of these 18 countries will support this view. The list includes: Spanish Sahara, Mauritania, Burundi, Basutoland, Bechuanaland, Spanish Equatorial Guinea, Swaziland, Falkland Islands, Portuguese Timor, West Irian, the Federation of South Arabia, Muscat-Oman, Qatar, Trucial Oman, Yemen, Bhutan, Sikkim, and Solomon Islands (U.K.). In Table 6 (Chapter II) we can see that these 18 countries comprise only 0.48 percent of the world's population.

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the number of countries at each level would be somewhat more evenly distributed. (A similar situation prevailed when we attempted to compute the rate of growth of the agricultural labor force.)

The second reason is that, in some respects, economic levels 2 and 3 are similar to each other and distinctly different from levels 1 and 4. For example, the unweighted means of the proportion of the labor force in agriculture in 1960 are distributed as follows:

<u>Economic Level</u>	<u>Number of Countries</u>	<u>(ALF/TLF)^a x 100</u>
1	10	75.68
2	15	63.23
3	19	57.32
4	21	41.28
5	27	21.94

^aALF = Agricultural labor force (males)
TLF = Total labor force (males)

Similarly, the average crude densities are about the same (35.70 and 34.60 persons per km²) in levels 2 and 3. (However, the agricultural densities are quite different: 27.00 and 40.56 in 1960.)

The following picture emerges after readjusting the initial economic groupings (p. 38 above). The four final economic levels can be designated as: poorly developed (level 1), moderately developed (level 2), developed (level 3), and highly developed (level 4).

<u>Initial Economic Grouping</u>		<u>Final Economic Grouping</u>	
<u>Level</u>	<u>Number of Countries</u>	<u>Level</u>	<u>Number of Countries</u>
1	31		
Probably 1	18	1 (Lowest)	49
2	24		
3	26	2	50
4	27	3	27
5	30	4	30
TOTAL	156	TOTAL	156

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General Descriptions of the Groupings. In Appendix Table IV, the 156 countries are listed according to the four economic levels. Here we can give a brief, general description of the countries in each of these levels.

Most of the Eastern, Western, and Middle and Southern African countries are classified in economic level 1. The Northern African countries (excluding Sudan and Spanish Sahara) and a few other African countries (e.g., Kenya and Congo) are in level 2. South Africa is in level 4.

The Latin American countries are about equally distributed in levels 2 and 3. Haiti is an exception; it is in level 1. The Caribbean and Middle American countries (except Mexico, Costa Rica, and Panama) are in level 2. Except for Bolivia, Ecuador, and the Guianas, the countries in Tropical South America are in level 3. Similarly, with the exception of Paraguay, the Temperate South American region is in level 3.

Among the Asian countries, Japan, Israel, and Kuwait are in level 4; Taiwan and Cyprus are in level 3. All other Asian countries are in levels 1 and 2. China (Mainland) is in level 2. Most of the Southeast Asian countries, with the major exceptions of the Philippines and Malaysia, are in level 1. Similarly, excluding Iran, Iraq, Lebanon, Syria, and Turkey, the Southwest Asian countries are in level 1. Ceylon, India, and West Pakistan are in level 2; other territories in South Central Asia are in level 1.

Among the European countries, Albania is the only country in level 2. All the Northern and Western European countries are in level 4. Czechoslovakia, East Germany, Hungary, Poland, and Italy are in level 4; all other countries in Eastern and Southern Europe are in level 3.

Australia and New Zealand are in level 4; all other major countries in Oceania are in level 2.

The U.S.S.R. is in level 4.

Classification of Countries According to Geographic Regions

As indicated earlier, the countries are classified into five geographic regions. The exact composition of each of the various regions is as follows:

(1) Africa: The whole of the African continent except for seven countries in Northern Africa--viz., Algeria, Libya, Morocco, Spanish Sahara, Sudan, Tunisia, and the U.A.R. Total number of countries: 41.

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(2) Middle East: The countries in Northern Africa and Southwest Asia (west of Afghanistan). Total number of countries: 22.

(3) Asia: All of the Asian countries except those in Southwest Asia. In addition, this region includes six countries in Oceania--viz., Fiji, New Caledonia, New Guinea, New Hebrides, Papua Island, and Solomon Islands. Total number of countries: 33.

(4) Frontier Countries: All the countries in the North and South American continents, along with the U.S.S.R., Australia, and New Zealand. The latter three countries are included in this category because, from the agricultural point of view (and other aspects such as natural resources), they closely resemble the majority of the American countries (excluding the Caribbean and other small countries). For example, low agricultural densities and prevalence of pasture are common characteristics. Total number of countries: 35.

(5) Europe: The whole European continent except the European part of the U.S.S.R. Total number of countries: 25.

Classification According to Geographic Subregions. The preceding classifications according to economic levels and geographic regions can be criticized for their great heterogeneity (wide variations in population and agricultural characteristics within the groups) and for the uneven distribution of the total population and total land area of the world among the groups. The heterogeneity will become obvious in the subsequent analysis from the high coefficients of variation within the groups; the uneven distribution of population and land area is shown in Table 8. The reason that one-half of the population is in economic level 2 is that China and India are classified in that group; the major disparity in the land area distribution results from the fact that six of the eight largest countries in the world are included in the Frontier Countries: Canada, the U.S., Brazil, Argentina, Australia, and the U.S.S.R. These six countries constitute about 84 percent of the total land area of the Frontier Countries, and 45 percent of the world's land area.

In view of these criticisms, we performed our analyses at a subregion level. The 22 subregions we used are derived from Davis, World Urbanization 1950-1970;² they are listed in Table 11 below (p. 60).

²Vol. I, pp. 52-53. The countries of area less than 5,000 km² are excluded from our list.

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Table 8

PERCENT DISTRIBUTION OF THE WORLD'S POPULATION
AND LAND AREA BY ECONOMIC LEVELS AND REGIONS
IN COUNTRIES OF 5,000+ km²: 1960

<u>Economic Level</u>	<u>Percent Distribution of:</u>	
	<u>Population</u>	<u>Land Area</u>
Level 1	12.58%	16.00%
Level 2	48.26	25.78
Level 3	9.77	15.81
Level 4	29.39	42.41
TOTALS	100.00	100.00
 <u>Region</u>		
Africa	6.82	16.38
Middle East	4.86	10.87
Asia	52.92	15.41
Frontier Countries	21.25	53.74
Europe	14.15	3.60
TOTALS	100.00	100.00
ABSOLUTE TOTALS (000's)	2,997,063	134,698 km ²

Relative Size of the Agricultural Populations

As previously noted, we are interested in measuring the relative size of that segment of the total population of each country which is dependent on the agricultural sector of the economy; we call this segment the "agricultural population." We collected data on three different but overlapping groups associated with agricultural industry: the economically active males in agriculture (ALF = agricultural labor force), the farm population (FARM), and the rural population (RURAL). It is of value to know the relative size of each of these groups, regardless of how well

the size of the agricultural population is measured.³ For instance, if it is known that 70 percent of the total labor force is engaged in agriculture, it can probably be assumed that the agricultural population is approximately 70 percent of the total population. Is this kind of conclusion always correct? Does it depend on the economic level of the country? Does it depend on the level of the measure (70 percent or 20 percent)? Does it depend on the location of the country (geographic region)? The answers to such questions require an extensive study of the various measures of agricultural populations. The main framework for the study of agricultural populations in this chapter was provided at the beginning of the chapter. It is our hope that the critical examination of the variations in ratios (involving the three measures of agricultural population) according to economic levels and geographic regions will reveal many important aspects of the dynamics of the agricultural population.

The material presented in this chapter is based upon the data provided in the Appendix Tables (pp. 253-308). According to their availability, the labor force data for each country are given in Appendix Table II; the farm population data in Table III; and the ratios involving total population, rural population, agricultural labor force, and farm population in Table V.

In the summary tables for the economic levels and the geographic regions, the unweighted and weighted means of the ratios are shown.⁴ The weighted means in this chapter are based on the

³The relative sizes of the three groups are indicated by three ratios: (1) the ratio of the agricultural labor force to the total labor force (ALF/TLF), (2) the ratio of the farm population to the total population (FARM/POP), and (3) the ratio of the rural to the total population (RURAL/POP).

⁴Let $\left(\frac{x_i}{y_i}\right)$ denote a ratio for the characteristic x and y in country i . We can compute two kinds of weighted means of the ratio for a group of n countries: (1) where the weights are the size of the numerator (x_i), and (2) where the weights are the size of the denominator (y_i).¹ When both the numerator and denominator are similar in character--e.g., both refer to populations or agricultural lands--the two weighted means are likely to be of the same magnitude. But when the numerator and denominator differ in character, the two weighted means may differ considerably. For example, the two weighted means of population densities may differ considerably when (1) the weights are the size of population in a country and (2) the weights are the size of area. For these reasons we are using only one kind of weighted mean (based on the denominator values) in this chapter. We shall use both kinds of

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use of the denominator values in the ratios as the weights. Thus, for example, the weighted mean of the ratio RURAL/POP for a group means that the ratio of each country is weighted by its total population (the denominator value).

Variations in the Proportions of the Rural Population and the Agricultural Labor Force According to Economic Levels

In Table 9, the proportion of the rural to the total population and the proportion of the agricultural labor force to the

weighted means in Chapter V, where we discuss the population/agricultural densities.

(The difference between the two weighted means is the direct function of the variability of ratios in a group of countries [to be discussed in Chapter V, pp. 169-172]. When the numerator and denominator differ in character, the two weighted means have important substantive meanings [pp. 149-154].)

For computational purposes, the following simplified expressions of the unweighted and weighted means can be used. All the sums (Σ) are from 1 to n--the number of countries.

(A) Unweighted measures.

$$\text{Mean: } \bar{x}_1 = \frac{1}{n} \Sigma \left(\frac{x_i}{y_i} \right)$$

$$\text{Variance: } v_1 = \frac{1}{n} \Sigma \left(\frac{x_i^2}{y_i^2} \right) - \bar{x}_1^2$$

(B) Weighted measures: Denominator values (y_i) in the ratios as the weights.

$$\text{Mean: } \bar{x}_2 = \frac{1}{(\Sigma y_i)} \Sigma \left(\frac{x_i}{y_i} \right) y_i$$

$$\text{or: } \bar{x}_2 = \frac{\Sigma x_i}{\Sigma y_i}$$

$$\text{Similarly, Variance: } v_2 = \frac{1}{(\Sigma y_i)} \Sigma \left(\frac{x_i^2}{y_i} \right) - \bar{x}_2^2$$

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total labor force are shown for the four economic levels.⁵ For each level the unweighted and weighted means are given for 1950 and 1960, the results being dependent on the availability of data in these years.

We note in Table 9 that the percent RURAL declines as we move up from economic level 1 to 4. The percent RURAL also declines from 1950 to 1960 in all the levels. It will be recalled that the countries were classified into economic levels according to electricity production in 1960. Since almost all the countries increased their per capita production of electricity from 1950 to 1960, economic growth can be assumed among the countries within each level. Therefore the decline in the proportion RURAL from economic levels 1 through 4 and the decline over time (1950 to 1960) within each economic level suggest a negative association between the proportion RURAL and economic growth.

Comparing the figures in columns (2) and (3) with those in columns (4) and (5), we find that the effect of weighting is considerable in economic level 2--the weighted means are higher by about five percentage points than the unweighted means in both

(C) Weighted measures: Numerator values (x_i) in the ratio as the weights.

$$\text{Mean: } \bar{x}_3 = \frac{1}{(\sum x_i)} \sum \left(\frac{x_i^2}{y_i} \right)$$

$$\text{Variance: } v_3 = \frac{1}{(\sum x_i)} \sum \left(\frac{x_i^3}{y_i^2} \right) - \bar{x}_3^2$$

Thus in order to compute the above measures, we need the values of six sums over the n countries in a group, viz.:

$$\sum x_i, \sum y_i, \sum \left(\frac{x_i^2}{y_i} \right), \sum \left(\frac{x_i^3}{y_i^2} \right), \sum \left(\frac{x_i^2}{y_i} \right), \text{ and } \sum \left(\frac{x_i^3}{y_i^2} \right).$$

⁵For brevity we shall use the expressions "proportion (or percent) RURAL" to denote "proportion (percent) of the rural population to the total population," and "proportion (or percent) ALF" to denote "proportion (percent) of the agricultural labor force to the total labor force" (TLF).

Table 9

RELATIVE SIZES OF AGRICULTURAL POPULATIONS AND MEANS ($\bar{x}$), STANDARD DEVIATIONS (sd),
AND SUMS OF WEIGHTS (w) BY ECONOMIC LEVELS AND REGIONS: 1950 AND 1960^a

(Weights for the weighted measures are in 000's)

Economic Level or Region	(Rural/Total Population) x 100				(ALF/TLF) ^b x 100			
	Unweighted		Weighted by D ^c		Unweighted		Weighted by D ^c	
	1950	1960	1950	1960	1950	1960	1950	1960
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Economic Level 1								
$\bar{x}$	91.68	88.61	91.07	88.66	84.64	76.67	82.42	76.09
sd	9.42	12.29	4.70	5.83	4.95	16.58	3.86	8.66
w	49	49	297,165	377,064	5	11	21,497	46,670
Economic Level 2								
$\bar{x}$	80.79	76.16	85.32	81.31	65.04	60.54	67.65	64.99
sd	11.09	12.13	5.45	5.61	10.95	11.66	5.46	5.58
w	50	50	1,183,000	1,446,510	23	33	136,277	186,924
Economic Level 3								
$\bar{x}$	64.53	56.67	60.52	52.86	49.10	43.66	53.33	48.49
sd	14.54	14.80	12.56	11.71	12.42	12.81	10.52	10.54
w	27	27	234,392	292,765	16	19	54,325	66,156

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Table 9 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Economic Level 4								
$\bar{x}$	48.24	42.87	47.08	40.83	29.44	22.78	24.98	21.00
sd	17.33	17.00	14.25	12.68	13.11	11.26	12.44	11.14
w	30	30	772,066	880,723	27	26	168,415	234,368
Africa								
$\bar{x}$	91.49	87.72	89.82	86.23	68.49	69.10	66.62	54.21
sd	8.28	10.25	9.64	10.91	20.30	18.33	17.81	19.79
w	41	41	155,899	204,280	4	10	12,646	9,498
Middle East								
$\bar{x}$	72.45	65.83	75.70	70.49	54.37	51.79	64.00	59.85
sd	17.82	18.48	10.75	11.65	19.97	18.28	10.71	10.55
w	22	22	113,143	145,663	7	12	17,831	32,917
Asia								
$\bar{x}$	87.38	83.79	85.13	81.21	65.46	62.80	65.05	62.86
sd	11.03	14.10	7.52	8.98	16.18	17.20	12.34	15.34
w	33	33	1,310,131	1,586,180	11	17	150,080	220,560

Table 9 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Frontier Countries								
$\bar{x}$	62.58	57.01	50.74	43.98	51.76	44.26	33.00	30.24
sd	16.62	18.50	12.52	12.09	20.29	20.22	21.62	18.63
w	35	35	515,237	636,836	27	29	90,570	158,142
Europe								
$\bar{x}$	52.10	46.42	46.62	41.92	33.08	28.55	30.72	23.89
sd	16.69	15.25	17.39	15.95	14.93	15.47	16.13	14.57
w	25	25	392,213	424,104	22	21	109,385	113,002
All Regions								
$\bar{x}$	75.14	70.29	71.80	67.56	49.29	47.90	47.55	44.62
sd	20.36	21.89	20.68	21.41	21.42	22.45	23.23	23.75
w	156	156	2,486,623	2,997,063	71	89	380,513	534,119

^aThe weight (w) shown in the table is the sum of weights in a group. Thus if $\frac{x_i}{y_i}$ is the ratio for a country in a group of n countries, then (a) Unweighted measure: w is the number of countries, n ;

(b) Weighted measure by the denominator: $w = \sum_{i=1}^n y_i$. (E.g., in the case of Economic Level 1, the w (377,064) in column 5 is the sum of the total populations of 49 countries.)

^b_{ALF} = Male agricultural labor force; TLF = Total male labor force.

^c_D = Denominator value of the ratio.

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1950 and 1960. This is because of the large variation among the countries of level 2, and because the proportions RURAL in China and India exert a great influence on the weighted average.⁶

An important thing to note is that the higher the economic level, the more heterogeneous the group with respect to the level of rural population--as the following figures indicate:⁷

Coefficient of Variation: 1960^a

Economic Level 1	0.0658
Economic Level 2	0.0690
Economic Level 3	0.2215
Economic Level 4	0.3105

^aThis is the ratio of the standard deviation to the mean ($\frac{sd}{\bar{x}}$). The figures shown are for the weighted measures.

Thus, among the more developed countries (levels 3 and 4) the proportion RURAL may not be closely correlated with economic level. For example, among those classified in economic level 4 (highly developed), one finds countries such as South Africa, Japan, Austria, Switzerland, Poland, and the U.S.S.R. with 45-50 percent RURAL in 1960, while Israel, the U.K., East Germany, West Germany, and Australia have a proportion RURAL of about 20 percent in 1960.

Among the economic level 3 countries, Uruguay shows a low percent RURAL (27.96 in 1960) and South Rhodesia shows a high percent (83.74 in 1960).

There is a sharp decline in the average percent RURAL from economic level 2 to 3 (from 81 to 53 in 1960). In a very general way, economic levels 1 and 2, on the one hand, and 3 and 4, on the other hand, form two distinct groups. In a later section we shall try to show that the level of rural population in economic level 3 is somewhat underestimated.⁸ If this is true, then the decline from level 2 to 3 would be less.

⁶The percents RURAL in China and India in 1960 are 83.45 and 82.06 respectively, which is why the weighted average for level 2 as a whole is 81.31 percent in 1960.

⁷Computed from column (5) in Table 9.

⁸The underestimation is in the socio-economic sense--i.e., the official definitions of urban areas are of a political and

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Columns (6) to (9) in Table 9 show the variations in percent ALF by economic levels. The overall pattern is similar to that of the rural population. In 1960 the average level of the percent ALF for the highest economic level (4) is less than one-third of the percent ALF for the lowest economic level (1). This wide variation between the poor and rich countries is at the crux of the economic and demographic problems of the less developed countries. The weighted means in column (9) show that the rate of decline in the percent ALF becomes greater as we move up from economic level 1 to 4. Thus we have:

	<u>Percent ALF 1960</u>	<u>Percent Decline^a</u>
Economic Level 1	76.09	
Economic Level 2	64.99	14.6
Economic Level 3	48.49	25.4
Economic Level 4	21.00	56.7

^aPercent decline in the percent ALF between the successive economic levels.

Disregarding economic level 1 (the number of countries at that level is very small in 1950), there is a moderate decline of about four percentage points during 1950-60 in the other three economic levels.

Let us assume that the labor force structures shown in column (9) of Table 2 are representative of all the countries in the various economic groups. Then comparisons of the levels of percent RURAL and percent ALF yield the following results:⁹

<u>Group</u> <u>(1)</u>	<u>Percent RURAL</u> <u>(2)</u>	<u>Percent ALF</u> <u>(3)</u>	<u>Ratio: (2)</u> <u>(3)</u>
Economic Level 1	88.66	76.09	1.165
Economic Level 2	81.31	64.99	1.251
Economic Level 3	52.86	48.49	1.090
Economic Level 4	40.86	21.00	1.946

administrative rather than socio-economic nature. (The definitions are based on urban characteristics, the labor force composition, etc.). We shall discuss this issue in detail in a later section on the interrelationship between the rural population and agricultural labor force (pp. 66-76).

⁹Computed from columns (5) and (9) in Table 9.

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If there is a linear trend in the ratios, economic level 3 is a misfit. However, with respect to economic levels 1, 2, and 4, the ratios are indicative of the higher proportion of non-farm population in the rural areas of the highly developed countries. (We shall discuss this point in a later section--pp. 66-76.)

In the same way that we provided coefficients of variation of the mean proportion RURAL by economic levels (p. 53), we can provide corresponding coefficients for the mean proportion ALF, as follows:¹⁰

Coefficient of Variation: 1960

Economic Level 1	0.1138
Economic Level 2	0.0859
Economic Level 3	0.2173
Economic Level 4	0.5305

It will be observed that the coefficients of variation in 1960 of the percent ALF (based on the weighted measures) are approximately the same as for the rural population for economic levels 1, 2, and 3 (see p. 53). But for economic level 4, the coefficient for the ALF (0.5305) is much higher than that for the RURAL (0.3105). This extremely high value of the coefficient of variation in economic level 4 naturally reflects the wide variety of conditions which determine the size of the agricultural labor forces in the highly developed countries. Some of these conditions are (1) the rate of natural increase of population, (2) the demand for agricultural products, both internal and external, (3) the level of income in the agricultural sector vs. other sectors, and (4) the productivity of agricultural labor. The combined effects of such conditions establish the rate of growth of the agricultural labor force, which is subsequently reflected in its size relative to the total labor force. (We shall discuss the determinants of the growth of agricultural labor force in Chapters V and VI. Here we shall merely describe the variations between countries.)

The lowest proportion ALF in the world is shown by the U.K. (5.9 percent in 1960). The U.S. and Belgium show a slightly higher proportion--about 8.5 percent in 1960. Among the countries of level 4, Ireland shows one of the highest percents ALF--43.2 in 1960. Countries closely trailing Ireland are Poland, Finland, and South Africa. All other countries of level 4 had a percent ALF less than 35 in 1960. All the highly developed countries show a decline in the percent ALF during 1950-60 (except Norway, which has a small increase). Curiously enough, with the exception of Ireland, the countries of economic level 4 which had a percent

¹⁰ Computed from column (9) in Table 9.

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ALF between 40 and 50 in 1950 show a decline in the proportion ALF as high as one percentage point per year as indicated by the following figures reproduced from Appendix Table 5:

<u>Country</u>	<u>Percent ALF</u>	
	1950	1960
Puerto Rico	44.88	27.78
Japan	39.50	25.55
Italy	40.27	28.12
Hungary	40.01	30.62
Poland	48.05	38.81
Finland	45.95	37.27
Ireland	47.53	43.16

Turning to economic level 3, we find that about one-half of the labor force is engaged in agriculture (cols. (8) and (9) of Table 9). Among the countries of this level, Surinam, Trinidad and Tobago, Argentina, and Uruguay (all in South America) show the lowest proportions ALF (22 percent) in 1960. Mexico and Colombia have the highest proportions ALF (about 60 percent in 1960) among the countries of economic level 3. This range of variation is reflected in a high coefficient of variation for the proportion ALF--.2173 in 1960.

Among the countries of economic level 3 for which we have data for both 1950 and 1960, the largest decline in the proportion ALF is shown in Spain (from 53 to 45 percent), and Yugoslavia (61 to 51 percent). In general, the proportion ALF declined by about five percentage points in the ten years.

Among the countries of economic level 2, the variation in the proportions ALF is not as great as that of levels 3 and 4. In most of these countries the proportion ALF is close to the mean value of the group--viz., 65 percent in 1960. Only two small countries--British Guiana (Guyana) and French Guiana--are far from the mean. Their proportion ALF is about 31 percent in 1960.

Among the economic level 2 countries, the Philippines and the Dominican Republic show a slight increase in the proportion ALF during 1950-60. Otherwise, according to the available data, the proportions remained static or declined. India is the only major country that shows no change from 1950-60. The most dramatic declines in the proportion ALF are shown by Algeria (from 73 to 62 percent), Thailand (88 to 77 percent), and Turkey (73 to 61 percent). (The labor force data for Thailand may be defective: the percentage of rural population does not decline during 1950-60.)

Results Based on Matched Data. As noted earlier, the calculations for Table 9 are based on the availability of data

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for 1950 and 1960. The countries having data for 1950 and 1960 may not be the same. In Table 10 the weighted means for the proportion ALF are given for the countries that have data for both 1950 and 1960--i.e., the countries that can be matched. In economic level 1, matching reduces the number of countries drastically--from eleven to two. The effects of matching on the weighted means of the proportion ALF in the three other levels are given below:¹¹

	Number of Countries for Which Data Are Available for:			Ratio: <u>Unmatched</u> <u>Matched</u> Proportion ALF	
	1950	1960	1950 & 1960	1950	1960
Economic Level 2	23	23	21	1.001	0.991
Economic Level 3	16	19	15	0.996	0.998
Economic Level 4	27	26	25	1.006	1.217

The figures above show that, except in the case of the 1960 ratio for economic level 4, matching has no significant effect on the overall measures. In other words, if the data on labor force are missing for a few countries, the weighted means of the proportion ALF for the economic levels at a particular time are not likely to be seriously affected, except in level 4.

These figures also lead to the conclusion that the changes in the proportion ALF in economic levels 2 and 3 are the same whether the countries are matched or unmatched. The proportion ALF, based on matched data, declines sharply from 25 percent in 1950 to 17 percent in 1960 in economic level 4--a decline of about 30 percent (cols. (3) and (6) in Table 10). This decline is in sharp contrast to the 16 percent shown by unmatched data--from proportion ALF of 25 percent in 1950 to 21 percent in 1960 (cols. (8) and (9) in Table 9). The substantial difference in the trend during 1950-60 produced by the matching of countries for economic level 4 is due mainly to the exclusion of the U.S.S.R.¹² The

¹¹Sources: The number of countries: cols. (6) and (7) in Table 9 and col. (2) in Table 10. The unmatched weighted proportions: cols. (8) and (9) in Table 9; the matched proportions: cols. (3) and (6) in Table 10. The results are not given for economic level 1 because of the extremely small number of countries in that group. The ratios are based on the weighted means of the proportions.

¹²The U.S.S.R. is excluded because it does not have labor force data for 1950. The ALF in the U.S.S.R. in 1960 is 17,973,000; the proportion ALF is 33.68 percent. Therefore a high proportion ALF with a significant weight (7.7 percent of the total ALF among the 26 countries of economic level 4 in 1960) is removed by the matching.

Table 10

PROPORTION OF LABOR FORCE IN AGRICULTURE, WEIGHTED BY THE DENOMINATOR VALUES,
FOR MATCHED COUNTRIES, ACCORDING TO ECONOMIC LEVELS AND REGIONS: 1950 AND 1960

(The sum of weights, w, is expressed in 000's)

Economic Level or Region	n	(ALF/TLF) x 100. Weighted by Denominator							
		1 9 5 0		1 9 6 0					
		$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Economic Level 1	2	84.27	3.32	13,096	84.69	3.09	15,576		
Economic Level 2	21	67.58	5.47	134,058	65.57	5.36	170,441		
Economic Level 3	15	53.54	10.61	52,719	48.58	10.42	62,688		
Economic Level 4	25	24.84	12.54	164,802	17.26	9.96	181,006		
Africa	1	38.57	0	3,612	35.72	0	4,404		
Middle East	7	64.00	10.71	17,831	57.39	7.72	21,339		
Asia	11	65.05	12.34	150,080	62.00	16.28	190,071		
Frontier Countries	24	31.94	21.01	87,379	27.86	22.70	101,323		
Europe	20	30.69	16.40	105,772	23.77	14.46	112,574		
<u>All Regions</u>	63	46.84	23.08	364,675	43.44	24.86	429,710		

Note: n = number of countries for which labor force data are available for both 1950 and 1960. For explanation of other symbols, see Table 9.

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declines in the proportion ALF are hardly 10 percent for economic level 3 and 3 percent for level 2. Such differences between the highly developed countries and the less developed countries are startling; they clearly reflect not only a lower rate of growth of the agricultural labor force, but also a great difference between the rates of growth of the agricultural and total labor forces among the highly developed countries. (We shall discuss these differences in detail in a later section--pp. 91-96).

Variations in the Proportions RURAL and the Proportions ALF According to Geographic Regions

Variations According to the Main Regions. The lower halves of Tables 9 and 10 show the relative sizes of the rural populations and the agricultural labor forces for the five main geographic regions. The coverage of the labor force data is quite poor for Africa, the Middle East, and Asia. (Compare the values of w in columns (2) and (3) with those in columns (6) and (7) in Table 9.) When we match the countries, there is only one country (South Africa) left in Africa, and only one-third of the total number of countries in the Middle East and Asia remain (see Table 10). Consequently, except for North Africa, the African continent is completely left out of any discussion of the growth of the ALF or changes in the proportion ALF.

Table 9 shows that Africa is the most ruralized region, closely followed by Asia. The Middle East is third in this ranking, with about three-fourths of the population living in rural areas.

If we compare the weighted means, the level of ruralization is roughly equal in the Frontier Countries and Europe in 1960--about 43 percent. It should be borne in mind that the Frontier Countries region is not composed along geographic lines. Australia, New Zealand, the U.S.S.R., Canada, and the U.S. make up about 67 percent of the total population of the Frontier Countries. Therefore the low proportion of the rural population in these countries contributes greatly to the overall weighted average of 44 percent for 1960. This factor is also reflected in the wide variation between the 1960 unweighted averages (57 percent) and weighted averages (44 percent) of the proportion RURAL in the Frontier Countries (as well as in the proportion ALF).

Variations According to Subregions. Since the five "main" geographic regions are highly heterogeneous (note the standard deviations), a better insight into geographic variations would be gained by studying the differences at the subregional level (see Table 11). In the tables on subregions, we do not show standard deviations, sums of weights, or unweighted means because (1) the subregions are usually homogeneous with respect to population and

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Table 11

WEIGHTED MEANS OF THE RELATIVE SIZE OF AGRICULTURAL
POPULATION ACCORDING TO SUBREGIONS: 1950 AND 1960(Weights are the denominator values of the ratios)

Subregions	$\left(\frac{\text{Rural}}{\text{Total}} \text{ Population}\right)$		$(\text{ALF/TLF}) \times 100$				
	$\times 100$		$\times 100$				
	1950	1960	1950	1960	1950	1960	
	n	$\bar{x}$	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Northern Africa	7	75.63	70.59	4	60.91	5	62.64
Western Africa	15	89.39	85.25	1	78.58	6	70.66
Eastern Africa	13	94.80	93.04	1	73.83	0	0
Middle and Southern Africa	12	93.41	88.41	1	82.99	3	65.26
South Africa [Republic]	1	60.86	55.13	1	38.57	1	35.72
Northern America	3	36.20	30.27	3	15.73	3	8.80
Middle America	8	60.82	53.77	8	61.78	8	61.55
Caribbean	7	64.06	60.98	5	57.91	4	48.33
Tropical South America	9	64.10	54.95	6	60.25	7	53.69
Temperate South America	5	40.86	34.96	3	31.12	4	27.05
East Asia	5	88.17	82.37	1	57.09	2	57.04
Japan	1	62.59	51.40	1	39.50	1	25.55
Southeast Asia	13	86.91	84.01	3	73.72	7	70.07
Southwest Asia	15	75.76	70.41	3	69.39	7	57.20
South Central Asia	8	84.56	83.56	5	69.25	5	68.07
Northern Europe	7	30.40	27.63	7	14.92	6	11.91
Western Europe	6	36.79	31.96	6	21.76	6	14.66
Eastern Europe	6	57.62	51.62	4	36.10	3	30.86
Southern Europe	6	59.61	54.50	5	47.95	6	39.17
Australia-New Zealand	2	30.00	22.29	2	18.01	2	14.69
Oceania	6	95.96	95.27	1	54.03	2	59.42
U.S.S.R.	1	57.51	49.90	0	0	1	33.38

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agricultural land characteristics, (2) the sums of weights, if needed, can be computed easily from the Appendix Tables, and (3) if we included standard deviations, sums of weights, and un-weighted means the tables would become very large.

In Table 11 we see that there is a substantial lack of data on the labor force in 1960 for the subregions of Eastern Africa, Middle and Southern Africa, East Asia, and Oceania. From 1950 to 1960, there is a notable improvement in the coverage in Western Africa, Southeast Asia, and Southwest Asia.

In the subregion of Northern Africa the level of the proportion RURAL is around 70 percent in 1960; the same level prevails in Southwest Asia. Because they are equally homogeneous for other socio-economic characteristics, we have combined these two subregions into the "Middle East."

In the Western, Eastern, and Middle and Southern parts of Africa, the level of ruralization is the highest in the world, and the change from 1950 to 1960 is only about three to five percentage points. As with other economic and demographic characteristics, South Africa [Republic] stands out as distinct from the other countries in Africa in the degree of ruralization, although its proportion RURAL is at the rather high level--on the international scale--of about 55 percent.

As expected, the Northern American subregion shows a much lower level of rural population (about 50 percent lower) than do other parts of the Americas--except the Temperate region of South America. (The level of Temperate South America is quite close to that of Northern America.)

Except for Japan and Southwest Asia, Asia as a whole is highly ruralized--about 85 percent--and shows little change from 1950 to 1960. (The similarities between Japan and South Africa [Republic] in proportion RURAL during 1950-60 are striking--particularly since the two countries are quite different in terms of both agricultural and historical development.)

With respect to the level of ruralization, Northern and Western Europe and Eastern and Southern Europe form two very distinct areas. The proportion RURAL in the latter area is roughly 80 percent higher than in the other. This explains why the coefficient of variation is so high for the European region as a whole.

The proportion RURAL of Australia and New Zealand is very similar to that of Northern Europe, Western Europe, and Northern America. These four subregions are the most highly urbanized regions in the world. They are also the most renowned for their economic development.

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In columns (5)-(8) of Table 11, the measures by subregions of the relative sizes of the agricultural labor forces are shown. With the exception of Middle America, the proportion ALF is less than the proportion RURAL in all the subregions for both 1950 and 1960. The degree of difference is not consistent. The general rule seems to be that the lower the level of the percent RURAL, the greater the difference (proportionally) between the proportions RURAL and ALF. The reasons for this will become clear in the next section when we discuss the interrelationships between the rural population and the agricultural labor force, and between the farm and non-farm components of the rural population. In the present section we shall discuss only briefly some of the highlights of the comparisons of the rural populations with the agricultural labor forces.

Unlike the proportions RURAL, the proportions ALF in Japan and South Africa are not similar. Although both countries started with the same proportion in 1950, by 1960 the proportion ALF in Japan is ten percentage points lower than in South Africa.

The trend during 1950-60 in the proportion ALF is quite similar in the Northern American and Northern European regions. The Northern American region has the lowest proportion ALF of all the regions--8.8 percent in 1960.

The changes in the percent RURAL and the percent ALF during 1950-60 between the Middle American and the Caribbean countries appear inconsistent. The decline of the proportion ALF in the Caribbean region during 1950-60 is much faster than in Middle America, but the proportion RURAL declines faster in Middle America than in the Caribbean.¹³

¹³ The rural population in Middle America seems to be underestimated (in the socio-economic sense) for 1960. As we noted on the page above, Middle America is the sole exception to the rule that the proportion ALF is less than the proportion RURAL. In examining the data on Middle America, we find that Mexico contains 75 percent of the total population of Middle America in 1960. Therefore, the data on Mexico would have a major impact on the weighted averages. Appendix Table V shows the following data for Mexico:

	<u>(RURAL/POP) x 100</u>	<u>(ALF/TLF) x 100</u>
1950	57.4	58.3
1960	49.3	59.3

As the country notes on Mexico indicate, a very careful adjustment of the ALF has been made, particularly with respect to the minimum age of 15 years in the labor force definition. We concluded that

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With respect to the rural populations, Eastern and Southern Europe are similar, but their labor forces differ in structure. The proportions ALF in Southern Europe are about ten percentage points higher in both 1950 and 1960 than are those in Eastern Europe.¹⁴

The unusually large difference between the proportions RURAL and ALF for Oceania is misleading, and is the result of a lack of data on the labor force.¹⁵

Estimates of the Proportion of Labor Force in Agriculture for the World in 1950 and 1960

At the bottom of Table 9 the weighted mean for the proportion ALF for all regions is shown as 47.55 percent in 1950 and 44.62 percent in 1960. However, these proportions are based on a "sample" of countries (71 countries in 1950 and 89 in 1960) which is biased with respect to the coverage of ALF. In the preceding

the 1960 estimate would be in error by one percent at most. The figures on the rural population are derived from the urban population as defined by the census. The urban definition is "agglomerations of minimum size of 2,500." Hence either the "urban population" includes considerable ALF (in which case the rural population is underestimated in the socio-economic sense), or the urban definitions are not the same for 1950 and 1960, or both. This problem requires more investigation.

¹⁴The reason for this difference may be the greater degree of agricultural mechanization and the larger share of females in agriculture in Eastern European countries than in Southern European countries.

Another reason may be that Eastern and Southern Europe are not really at the same level of ruralization. In a subsequent section (pp. 83-88), we point out that the rural populations of Greece and Spain are underestimated. If this is true, then the weighted means of percent RURAL in Southern Europe would be higher than in Eastern Europe, because Spain and Greece together account for 33 percent of the total population of Southern Europe in 1960.

¹⁵The only two countries in the Oceania region for which labor force data are available in 1960 are Fiji Island (64 percent ALF/TLF) and New Caledonia (36 percent ALF/TLF). New Caledonia's ALF proportion is unusually low, but this is consistent with its having the lowest proportion RURAL (60 percent) in the Oceania region. New Guinea, with 55 percent of the total population of Oceania in 1960, does not have labor force data. New Guinea is 100 percent rural in 1960. This explains the effect of lack of data on the proportion ALF in Oceania.

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discussion, we have often pointed out that the coverage of data is poor among the countries of economic levels 1 and 2. The following table shows the distribution of the total population and the total labor force (the factor of weighting used in the computation of the proportion ALF) for the four economic levels:¹⁶

	Percent Distribution of Population Groups According to the Availability of Data			
	1950		1960	
	Total Population (1)	TLF (2)	Total Population (3)	TLF (4)
Economic Level 1	11.95	5.65	12.58	8.74
Economic Level 2	47.57	35.81	48.26	35.00
Economic Level 3	9.43	14.28	9.77	12.38
Economic Level 4	31.05	44.26	29.39	43.88
<u>All Countries</u>	100.00	100.00	100.00	100.00

If we assume that the labor force participation rates for males are the same everywhere, then the coverage of the labor force data is such that economic levels 3 and 4 are over-represented at the expense of economic levels 1 and 2. Therefore, on the basis of available data, the weighted means of proportion ALF underestimate the proportion ALF of the world. In order to remove this bias, we compute the following weighted mean:

$$\bar{x} = \sum_{i=1}^4 p_i r_i$$

where p_i = proportion of the total population of the world living among the countries of economic level i (shown in columns (1) and (3) in the above tabulation), and r_i = the percentage of labor force in agriculture for economic level i (shown in columns (8) and (9) in Table 9).

This method assumes that the proportion ALF in the "non-sample" countries is the same as that in the "sample" countries (i.e., for which data are available) within a given economic level.

¹⁶ Columns (1) and (3) computed from sum of weights "w" in columns (4) and (5) of Table 9; columns (2) and (4) computed from "w" values in columns (8) and (9) of Table 9.

The use of this formula for $\bar{x}$ produces estimates of the proportion ALF for the world of 54.8 percent in 1950 and 51.9 percent in 1960. These estimates are about seven percentage points higher, in both 1950 and 1960, than those shown in Table 9. Hence, during the decade 1950-60, the proportion ALF in the world declined by 5.3 percent.

A Simple Model for Understanding the Decline in the Proportion ALF

In the preceding discussion, we have shown that the decline in the proportion ALF during 1950-60 is almost a universal phenomenon. In this section, with the help of a few hypothetical examples, we shall describe the mechanism of decline in the proportion ALF in terms of the rates of growth of the agricultural and total labor forces.

It is a simple corollary that when the proportion ALF declines, the rate of growth of the ALF is less than that of the TLF. Further, if

μ_a = rate of growth of ALF during the decade;

μ_t = rate of growth of TLF during the decade;

A_1 and T_1 = ALF and TLF at the beginning of the decade;

A_2 and T_2 = ALF and TLF at the end of the decade;

then the absolute change in the proportion ALF can be written as:

$$\frac{A_2}{T_2} - \frac{A_1}{T_1} = \frac{A_1}{T_1} \frac{(1 + \mu_a)}{(1 + \mu_t)} - \frac{A_1}{T_1} = \frac{A_1}{T_1} \left[\frac{\mu_a - \mu_t}{1 + \mu_t} \right] \quad (1)$$

and the relative change in the proportion would be:

$$x = \frac{A_2/T_2 - A_1/T_1}{A_1/T_1} = \frac{\mu_a - \mu_t}{1 + \mu_t} \quad (2)$$

A special case in equation (2) is when $\mu_a = 0$. Then the corresponding value of μ_t would be:

$$\mu_t^1 = \left(\frac{x}{1+x} \right) \quad (3)$$

For a given relative change in proportion ALF (x), μ_t^1 is the rate of growth of the TLF associated with the zero growth rate of the ALF. Generally, once a country achieves $\mu_a = 0$, it continues to have a negative rate of growth. Therefore, under

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the given conditions, μ_t^1 denotes the situation after which the ALF would decline in absolute numbers.

Table 12 shows the values of μ^a , based on equation (2), for given values of x and μ_t . The values of μ_t^1 are specially marked in the table--i.e., the values of μ_t that are associated with zero growth of the ALF. The higher the relative decline in the proportion ALF (i.e., x), the higher the rate of growth of the TLF which would be consistent with zero growth of the ALF. For example, in a country with proportions ALF of .35 and .30 in 1950 and 1960 respectively (Case III), the TLF may increase by 10 percent in ten years. Then the given decline of the proportion ALF would mean that the ALF had been reduced by 7.3 percent (see Table 12). If the growth of the TLF remained the same, but the proportion ALF declined from .75 to .70 (Case I), Table 12 shows that the predicted growth of the ALF would have been 2.6 percent. In earlier sections we saw that it is not unusual for a decline in the proportion ALF from .45 to .40 to occur in ten years (Case II). Such a decline in the proportion means that the ALF will decline in absolute number if the rate of growth of the TLF is less than 1.25 percent (value of μ_t^1) per year. (We shall use the results of this model in Chapter VI, pp. 197-199.)

Interrelationships Between the Different Measures of Agricultural Populations

We have observed that, with the exception of Middle America, the proportion RURAL always exceeds the proportion ALF (see Table 11). Further, we have demonstrated that the ratio of the two proportions (i.e., the ratio of the proportion RURAL to the proportion ALF) increases as we move up in the scale of economic levels (p.). This suggests a relationship between the absolute size of the rural population and the size of the agricultural labor force according to economic levels. For similar reasons, we shall examine the relationships between the absolute size of the farm population and that of the rural population (FARM/RURAL), and between the farm population and the agricultural labor force (FARM/ALF).

Relationship Between the Farm Population and the Rural Population

In Chapter II, we defined the farm population as the population living in households "whose head derives a livelihood from agriculture." Thus the "rural population" would include more than the "farm population." The non-farm rural population can be divided into two parts: (1) those servicing the farm population (for instance, persons associated with the sale and maintenance of agricultural machinery or the sale of fertilizers) and (2) those who are completely independent of agricultural activities

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Table 12

HYPOTHETICAL VALUES OF THE GROWTH OF THE ALF (μ_a)
CORRESPONDING TO THE GIVEN RELATIVE CHANGE^a
IN THE PROPORTION ALF (x) AND THE GROWTH RATE OF THE TLF (μ_t)

Proportion ALF		Case I	Case II	Case III
1950	A_1/T_1	.75	.45	.35
1960	A_2/T_2	.70	.40	.30
	x	-.067	-.111	-.143
		μ_t μ_a	μ_t μ_a	μ_t μ_a
		.300 .213	.300 .156	.300 .114
		.250 .166	.250 .111	.250 .071
		.200 .120	.200 .067	.200 .028
		.150 .073	.150 .022	.167 .000
		.100 .026	.125 .000	.150 -.014
		.072 .000	.100 -.022	.100 -.073
		.050 -.020	.050 -.066	.050 -.100
		.000 -.067	.000 -.111	.000 -.143
		-.050 -.114	-.050 -.155	-.050 -.186
		-.100 -.174	-.100 -.200	-.100 -.229

NOTE: μ_a and μ_t are for any ten-year period.

--the "adventitious rural population."¹⁷ Zelinsky gives the following description of the adventitious rural population:

The adventitious rural dwellers include the dispersed commuters to urban jobs, the employees of industrial plants of certain commercial and transportation enterprises in rural settings, military personnel, college students or institutional inmates resident in rural localities, retired persons and seasonal visitors enjoying the amenities of a bucolic existence, and, finally, all those persons who subsist by catering to the needs of this adventitious population.¹⁸

It can be hypothesized that the size of the "servicing" population would increase with an increase in the use of industrial inputs in agriculture. Similarly, as Zelinsky hypothesizes, the size of the adventitious population is directly proportional to the degree of socio-economic development. These two hypotheses, if true, would lead to the conclusion that the proportion of farm to rural population should decline with a rise in the economic level of a country.¹⁹

It should be stressed that the distinction between farm and non-farm rural populations may be virtually meaningless in the less developed countries, because almost the whole population may be involved in agricultural operations. At times of harvesting and ploughing, all the working population (of both sexes) in a village may be working in the fields. During the interim periods, everyone may be performing non-agricultural tasks or staying idle. It is not, then, surprising that the relative coverage of the

¹⁷The term "adventitious rural population" was coined by S.W.E. Vance, "Reflections on the Structure and Distribution of Rural Population in England and Wales, 1921-31," Transactions and Papers, Institute of British Geographers, No. 18 (1952), p. 53.

¹⁸Wilbur Zelinsky, "Rural Population Dynamics as an Index of Social and Economic Development: A Geographic Overview," The Sociological Quarterly, IV, 2 (Spring 1963), p. 102.

¹⁹If mechanization of agriculture caused outmigration of the ALF, it would not only increase the size of the servicing population, but would also decrease the size of the farm population. This would decrease the ratio FARM/RURAL faster than if only "servicing" and "adventitious" populations were increasing. Perhaps this explains why, in addition to other things, in the highly developed countries the ratio FARM/RURAL is substantially lower, and RURAL/ALF substantially higher, than the respective ratios in less developed countries (see Tables 13 and 14).

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data on the ALF vs. the farm population is poor in the population censuses of the less developed countries, as the following tabulation shows:²⁰

	Number of Countries for Which Population Censuses around 1960 <u>Tabulated Data on:</u>		
	Farm Population (1)	ALF (2)	$\frac{(1)}{(2)} \times 100$
Economic Level 1	0	11	0.0
Economic Level 2	4	34	11.7
Economic Level 3	5	19	26.3
Economic Level 4	13	26	50.0

It would seem that almost all the labor force among the farm population (as defined by a census) would be engaged in agriculture, but this is not the case. In the United States, for example, the breakdown is as follows:²¹

	Percent Distribution of the U.S. Farm Population 14+ Years: <u>April 1960 and April 1968 (Males)</u>	
	<u>1960</u>	<u>1968</u>
Labor Force	58.7	59.4
Not in Labor Force	<u>41.3</u>	<u>40.6</u>
	100.0	100.0
Labor Force		
<u>Employed</u>	97.2	98.4
In Agriculture	64.2	57.2
In Non-agriculture		
Industries	33.0	41.4
<u>Unemployed</u>	<u>2.8</u>	<u>1.6</u>
	100.0	100.0
Total Males (14+)	5,598,000	4,000,000

²⁰Column (1) compiled from Appendix Table IV; column (2) compiled from column (5) in Table 13 below.

²¹Current Population Reports. Farm Population of the United States, Series P-27, No. 40, July 31, 1969, p. 7, Table 3.

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The proportion of "farm" labor force employed in non-agricultural industries is substantial.²² Because of this factor and other factors mentioned in the section on farm population in Chapter II (pp. 24-26), the farm populations obtained through agricultural and population censuses may differ, though it is difficult to determine how much the differences in absolute size might be. Nevertheless, it is worthwhile to calculate ratios, etc. based on the farm populations as they are reported.

FARM/RURAL Ratios by Economic Levels. The ratios of the farm to the rural populations according to economic levels (Table 13) show that the ratio is highest--.88 in 1960--for economic level 1, is approximately the same for levels 2 and 3, and declines drastically--from .80 to 0.56 in 1960--between levels 3 and 4. The ratios based on the data from matched countries (Table 14) have a similar pattern. Both Tables 13 and 14 show a substantial decline in the ratio FARM/RURAL (from 0.668 to 0.559) during 1950-60 for economic level 4, but in the other economic groups there is very little change. This suggests that the factors which greatly reduce the proportion of farmers in the rural population operate only among the highly developed economies. Highly mechanized farming can only be performed within very developed economies--the same countries that have conditions favorable to the growth of "adventitious" and "servicing" rural populations. It should be noted, however, that the ratios FARM/RURAL vary considerably among the countries of economic level 4 (the coefficient of variation is 36.5 percent in 1960). We can make definite assertions about the determinants of farm population size only if we can explain this variation. We shall begin by analyzing the ratios in detail according to geographic subregions.

FARM/RURAL Ratios by Geographic Regions. Tables 13 and 14 show the agricultural population ratios for the five main geographic regions. In Table 13 we can see that the coverage of the farm population data in Africa improved dramatically during 1950-60: approximately 12 African countries took their first agricultural censuses with the cooperation of the Food and Agriculture

²²The farm population in the United States is defined as "all persons living in rural territory on places of ten or more acres if as much as \$50 worth of agricultural products were sold from the place in the reporting year." It also includes "those living on places of under ten acres if as much as \$250 worth of agricultural products were sold from the place in the reporting year." If the definition in the United States had been "members of households whose head is engaged in agriculture"--the definition we have preferred because it relates to the agricultural labor force rather than to the agricultural holding--the 33 percent of males "in non-agricultural industries" would not have been included in the farm population.

Table 13

INTERRELATIONSHIPS BETWEEN THE AGRICULTURAL POPULATIONS ACCORDING TO ECONOMIC LEVELS AND REGIONS

(Means of the ratios are weighted by their denominator values;
the sum of weights, w, is expressed in 000's)

Economic Level or Region	FARM/RURAL		RURAL/ALF		FARM/ALF	
(1)	1950	1960	1950	1960	1950	1960
	(2)	(3)	(4)	(5)	(6)	(7)
Economic Level 1						
$\bar{x}$	.862	.878	4.324	4.599	--	4.041
sd	.086	.086	.302	.411	--	.819
w	4,684	52,720	17,718	35,511	--	1,734
n	5	11	5	11	0	4
Economic Level 2						
$\bar{x}$	.808	.779	4.658	4.608	3.768	3.362
sd	.020	.054	.372	.458	.203	.365
w	840,034	1,043,676	92,189	122,102	68,008	105,001
n	10	20	23	34	7	17
Economic Level 3						
$\bar{x}$	.811	.797	3.865	3.994	3.117	3.202
sd	.153	.165	.701	.736	.473	.461

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Table 13 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
w	62,338	71,577	28,972	32,081	15,289	16,057
n	14	20	16	19	11	16
Economic Level 4						
$\bar{x}$	.668	.559	5.976	6.982	3.455	3.913
sd	.185	.204	1.508	2.413	.639	.787
w	327,646	338,520	42,071	42,219	37,277	48,322
n	22	24	27	26	21	24
Africa						
$\bar{x}$	.769	.857	4.736	5.016	--	4.245
sd	.094	.087	.415	.616	--	.691
w	10,814	66,398	8,425	5,761	--	4,113
n	4	18	4	11	0	8
Middle East						
$\bar{x}$	.894	.754	4.107	4.515	3.598	3.342
sd	.052	.120	.471	.567	.260	.793
w	7,365	46,775	11,413	19,701	1,830	10,299
n	3	7	7	12	3	6
Asia						
$\bar{x}$	.804	.780	4.793	4.732	3.849	3.480
sd	.033	.060	.518	.669	.246	.497

Table 13 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
w	880,521	1,049,130	97,621	138,635	74,998	101,704
n	9	13	11	17	5	11
Frontier Countries						
$\bar{x}$	.710	.582	5.028	5.664	3.256	3.940
sd	.207	.223	1.848	2.731	.396	.573
w	189,938	194,922	29,890	47,820	13,336	28,774
n	16	17	27	29	12	16
Europe						
$\bar{x}$	.644	.545	4.895	5.670	3.092	3.101
sd	.175	.195	1.484	2.026	.476	.452
w	146,064	149,265	33,601	26,996	30,410	26,224
n	19	20	22	21	19	20
All Regions						
$\bar{x}$	.771	.733	4.805	5.013	3.589	3.510
sd	.120	.149	1.087	1.566	.479	.595
w	1,234,702	1,506,494	180,949	238,913	120,574	171,114
n	51	75	71	90	39	61

Table 14

INTERRELATIONSHIPS OF THE AGRICULTURAL POPULATIONS AMONG COUNTRIES MATCHED IN 1950 AND 1960

(Means of the ratios weighted by their denominator values;
the sum of weights, w, is expressed in 000's)

Economic Level or Region	FARM/RURAL		RURAL/ALF		FARM/ALF	
	1950	1960	1950	1960	1950	1960
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Economic Level 1						
$\bar{x}$	.858	.888	4.276	4.264	--	--
sd	.084	.087	.242	.197	--	--
w	4,535	5,376	11,036	13,192	--	--
n	2	2	2	2	0	0
Economic Level 2						
$\bar{x}$	.808	.780	4.651	4.579	3.784	3.299
sd	.016	.048	.371	.403	.146	.149
w	836,072	965,585	90,602	111,761	66,968	85,040
n	7	7	21	21	4	4
Economic Level 3						
$\bar{x}$	.811	.799	3.882	3.930	3.117	3.216
sd	.153	.166	.702	.694	.473	.446
w	62,338	64,396	28,226	30,455	15,289	14,913
n	14	14	15	15	11	11

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Table 14 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Economic Level 4						
$\bar{x}$	.668	.552	5.967	7.574	3.456	3.605
sd	.185	.205	1.527	2.866	.639	.915
w	327,590	323,664	40,932	31,246	37,262	27,803
n	21	21	25	25	20	20
Africa						
$\bar{x}$	.769	.860	5.443	5.609	--	--
sd	.094	.086	0	0	--	--
w	10,814	13,152	1,393	1,573	--	--
n	4	4	1	1	0	0
Middle East						
$\bar{x}$	.894	.866	4.107	4.536	3.598	4.224
sd	.052	.086	.471	.331	.260	.253
w	7,365	8,263	11,413	12,247	1,830	1,693
n	3	3	7	7	3	3
Asia						
$\bar{x}$	.804	.778	4.793	4.688	3.850	3.426
sd	.033	.058	.518	.706	.243	.478
w	880,135	1,004,259	97,621	117,851	74,954	91,386
n	6	6	11	11	4	4

Table 14 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Frontier Countries						
$\bar{x}$	.710	.581	5.116	5.509	3.299	3.278
sd	.208	.225	1.873	3.540	.363	.279
w	186,213	191,209	27,907	28,226	12,340	9,660
n	13	13	24	24	10	10
Europe						
$\bar{x}$	.644	.540	4.845	5.679	3.092	3.070
sd	.175	.198	1.484	2.033	.475	.439
w	146,008	142,138	32,462	26,757	30,395	25,016
n	18	18	20	20	18	18
All Regions						
$\bar{x}$	.771	.727	4.815	4.952	3.597	3.356
sd	.120	.150	1.101	1.729	.472	.488
w	1,230,535	1,359,022	170,796	186,654	119,519	127,756
n	44	44	63	63	35	35

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Organization (FAO) under its 1960 World Census of Agriculture Program. The coverage of the farm population in the Middle East and Asia, on the other hand, remains unsatisfactory.

According to the available data, more than three-fourths of the rural population in Africa, the Middle East, and Asia is composed of farm population, while the proportion in Europe is the same as in economic level 4.

Table 15 shows the agricultural population ratios by sub-regions. In all parts of Africa, more than 84 percent of the rural population in 1960 is made up of farm population--the highest percentage among all the subregions. The Northern American sub-region has the lowest proportion of farm population within the rural population. As is well known, the farming of this subregion is highly mechanized and industrialized.

However, a low ratio FARM/RURAL is not always due to mechanized farming. If farms are abandoned, for whatever reason, the ratio declines drastically. The abandonment of farms seems to be the main reason for the lowest value of the FARM/RURAL ratio in our sample--.18 shown by the U.K. in 1960. (The U.K. also has the lowest proportion of its labor force in agriculture.)²³

The FARM/RURAL ratio for Middle America is based on only two countries, and does not include Mexico. However, if Mexico had been included, the ratio would remain around .75, because about two-thirds of Mexican labor is engaged in agriculture.

The low value (.56) of the ratio FARM/RURAL in the Caribbean is misleading because of the lack of farm population data for

²³The general decline in importance of the agricultural sector in the U.K. is well known. It is attributed to the long history of industrialization in England, the out-migration of rural and urban populations to foreign lands, and the phenomenon known as the "enclosure movement." Another important factor that has not received enough attention is that England's agricultural needs (particularly the industrial crops) have been largely met by her overseas colonies.

There are several studies of the evolution of England's rural population. For a detailed listing of references, see Zelinsky, p. 104. Some other important examples are: J. Beaujeu-Garnier, Geography of Population (London: Longmans, Green and Company, Ltd., 1966), pp. 214ff.; John Saville, Rural Depopulation in England and Wales 1851-1951 (London: Routledge and Kegan Paul, 1957); M.I. Isobel Robertson, "The Occupational Structure and Distribution of Rural Population in England and Wales," Scottish Geographical Magazine, 77 (December 31, 1961), pp. 165-179.

Table 15

INTERRELATIONSHIPS OF THE AGRICULTURAL POPULATIONS ACCORDING TO SUBREGIONS
(Means of the ratios weighted by their denominator values)

Subregion	FARM/RURAL				RURAL/ALF				FARM/ALF			
	1950		1960		1950		1960		1950		1960	
	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$
Northern Africa	1	.907	2	.888	4	4.355	5	4.521	1	3.587	1	4.219
Western Africa	2	.796	6	.842	1	4.536	7	4.795	0	--	4	4.153
Eastern Africa	2	.737	6	.876	1	5.061	0	--	0	--	0	--
Middle and Southern Africa	0	--	5	.860	1	2.515	3	4.763	0	--	3	3.848
South Africa [Republic]	0	--	1	.793	1	5.443	1	5.609	0	--	1	4.447
Northern America	2	.433	3	.260	3	7.963	3	13.109	2	3.445	3	3.404
Middle America	2	.820	2	.778	8	3.753	8	3.500	2	3.156	2	3.584
Caribbean	3	.673	2	.564	5	3.897	4	5.950	2	2.333	2	4.001
Tropical South America	2	.851	3	.845	6	4.067	7	4.168	2	3.393	2	3.280
Temperate South America	4	.646	4	.638	3	4.429	4	4.679	2	2.830	4	2.984
East Asia	3	.817	3	.815	1	2.861	2	4.956	1	3.324	2	4.399
Japan	1	.724	1	.719	1	6.055	1	7.007	1	4.385	1	5.041
Southeast Asia	1	.805	7	.713	3	4.925	7	4.864	1	4.454	6	3.437
Southwest Asia	2	.758	5	.725	3	3.728	7	4.508	2	3.751	5	3.184
South Central Asia	1	.797	1	.738	5	4.674	5	4.528	1	3.758	1	3.299
Northern Europe	7	.423	6	.330	7	6.567	6	7.476	7	2.778	6	2.471
Western Europe	6	.555	6	.408	6	5.848	6	7.463	6	3.247	6	3.043
Eastern Europe	1	.772	2	.696	4	5.191	3	5.342	1	3.575	2	3.775
Southern Europe	5	.752	6	.656	5	3.966	6	4.664	5	2.983	6	3.059
Australia-New Zealand	2	.438	2	.484	2	5.353	2	5.147	2	2.346	2	2.491
Oceania	3	.692	1	.486	1	5.412	2	5.492	1	2.127	1	3.080
U.S.S.R.	1	.869	1	.732	0	--	1	5.952	0	--	1	4.355

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this region--specifically, for such populous Caribbean countries as Cuba, Haiti, and the Dominican Republic.²⁴

The subregion of Tropical South America shows a ratio at the level of the African subregions. However, this figure is based upon incomplete and perhaps spurious data.²⁵

A value of .64 in 1960 for the ratio FARM/RURAL in Temperate South America is consistent with the high economic level of countries in this region--e.g., Chile, Argentina, Uruguay.

²⁴The ratio .56 in 1960 is based on Jamaica and Trinidad and Tobago. Trinidad and Tobago has a very low value of .34 in 1960, which seems to be consistent with the 21 percent of its labor force in agriculture.

²⁵Data on farm population are available for only three of the nine countries in this subregion in 1960--Colombia, Surinam, and Venezuela. Thus the largest country, Brazil, is not included. In addition, the rural populations in Colombia and Venezuela are probably underestimated. (The problem is similar to that of Mexico, as discussed in footnote 13, pp. 62-63. Also, in footnote 8, p. 53, we noted the possibility of underestimation of rural populations among economic level 3 countries; Venezuela and Colombia are in level 3.)

We shall take up the case of Colombia in the next section, on RURAL/ALF. Here we shall point out the inconsistencies of data for Venezuela. From Appendix Table V, the following ratios are reproduced for Venezuela:

	$\frac{\text{RURAL}}{\text{POP}} \times 100$	$\frac{\text{ALF}}{\text{TLF}} \times 100$	$\frac{\text{FARM}}{\text{RURAL}} \times 100$	$\frac{\text{RURAL}}{\text{ALF}}$
1950	54.81	41.97	71.16	4.97
1960	37.57	37.01	86.93	4.14

The decline in the proportion RURAL from 1950-60 is much faster than the decline in the proportion ALF. However, the proportion RURAL is equal to the proportion ALF in 1960. This violates the general rule that "the proportion RURAL should be greater than the proportion ALF" (see p. 62 above).

In addition, the FARM/RURAL proportion significantly increased during 1950-60, instead of decreasing or remaining constant, as we would expect. The definition of an urban area in Venezuela is "places 2,500+". As we noted for Mexico, there could be several places having more than 2,500 persons which should be classified as rural--in the socio-economic sense.

Therefore, the available evidence supports the contention

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It is interesting to note that the ratio for Japan is comparable to that of other parts of Asia, except the subregion of East Asia.²⁶ This supports the hypothesis that the proportion of farm population within the rural population is negatively associated with agricultural mechanization. Although economically highly developed, Japan has a labor-intensive agricultural system.

The Northern European subregion as a whole has a very low FARM/RURAL ratio (.33 in 1960), but there is great variation among its countries:

FARM/RURAL: 1960

Denmark	.72
Finland	.72
Ireland	.64
Sweden	.32
Norway	.30
United Kingdom	.19

It seems that the level of the ratio is directly proportional to the importance of the agricultural sector in the above countries. The abandonment of farms in the U.K., for example, is a well-known historical phenomenon (see footnote 23 above). In contrast

that the official census definition underestimates the rural population in 1960 (in the socio-economic sense). If we assume that the 1950 RURAL/ALF ratio holds for 1960, the results are:

	$\frac{\text{RURAL}}{\text{POP}} \times 100$	$\frac{\text{ALF}}{\text{TLF}} \times 100$	$\frac{\text{FARM}}{\text{RURAL}} \times 100$	$\frac{\text{RURAL}}{\text{ALF}}$
1950	54.81	41.97	71.16	4.97
1960	48.33	37.01	67.56	5.33

Now the pattern is consistent with those of other countries.

²⁶ In Table 15 the ratio FARM/RURAL for East Asia of .81 in 1960 is based on three countries: Taiwan (1.27), China (.81), and South Korea (.80). The data on farm population for China were taken from FAO's Production Yearbook, and are presumably estimates arrived at by the FAO. Hence their quality cannot be easily evaluated, especially since agricultural labor force data are absent. The ratio of 1.27 for Taiwan is clearly an error. Farm population in Taiwan is obtained through its 1960 agricultural census; therefore, it is unlikely that the farm population is overestimated. Thus the underestimation of the rural population is a strong possibility.

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to Northern Europe, Western Europe is fairly homogeneous.²⁷ For Eastern Europe there is a serious lack of data on the farm population, but the results obtained seem to be consistent with other measures. Southern Europe has considerable variation. In Albania, Greece, and Spain, for example, more than 80 percent of the rural population is farm population, while in Italy the proportion is 48 percent in 1960.²⁸

The ratio of .48 in 1960 for Australia and New Zealand seems to be due to the highly advanced agriculture in that region.

On the whole, we find that the ratios of farm to rural populations vary widely throughout the world. The ratio seems to be a good measure of the level of technology in agriculture: the higher the technological level, the lower the ratio. In "labor-intensive" agricultural systems, at least three-fourths of the rural population is dependent on agriculture. However, a very low ratio (below .20) may indicate the demise of the agricultural sector in an economy.

In this section we have shown many examples of the evaluation of rural population data by comparing them with agricultural labor force and farm population data. This is a by-product of comparative research.

²⁷ The standard deviations (weighted) of the ratio are .2035 in Northern Europe and .0532 in Western Europe in 1960.

²⁸ The high ratios for Spain and Greece may be due to underestimation of the rural populations in these countries. We shall discuss the rural populations of Spain and Greece in the next section, on RURAL/ALF: here we shall compare the data for Spain and Portugal:

		$\frac{\text{RURAL}}{\text{POP}} \times 100$	$\frac{\text{ALF}}{\text{TLF}} \times 100$	$\frac{\text{FARM}}{\text{RURAL}} \times 100$	$\frac{\text{RURAL}}{\text{ALF}}$
Spain	1950	51.26	53.15	92.40	2.97
	1960	46.09	44.86	87.75	3.29
Portugal	1950	68.78	51.28	60.52	4.61
	1960	66.14	47.98	63.67	4.75

In neighboring countries like Spain and Portugal, such a large difference in the relative sizes of the rural populations seems unlikely--particularly when the relative sizes of their agricultural labor forces are so close. Portugal's statistics for 1960 on farm population come from the 1960 census of agriculture. Therefore it seems likely that the rural population is underestimated in Spain.

Relationship Between the Rural Population and the Agricultural Labor Force

So far we have discussed variations of all three measures of agricultural population--RURAL, FARM, and ALF--according to economic levels and geographic regions. Therefore there is no need for an extensive discussion of the relationship between the rural population and the agricultural labor force (as measured by the ratio RURAL/ALF). The causes of an unusually high or low RURAL/ALF ratio for an individual country or subregion can be extrapolated from our discussion of the relative sizes of rural populations and of agricultural labor forces. Here we shall briefly analyze some of the material presented in Tables 13, 14, and 15, with emphasis on an evaluation of the rural population in a few countries. We shall begin with a discussion of a few theoretical considerations that are important in the interpretation of RURAL/ALF ratios.

In evaluating the ratio RURAL/ALF, we should bear in mind a basic difference between the concepts of rural population and of agricultural labor force. The concept of rural population in a country is the result of a dichotomous division based on special criteria. There is no such dichotomy involved in determining a person's occupation. Occupation is a personal characteristic, while "rural/urban" is a community characteristic. Rural populations may not be comparable between countries.

The data used for determining the rural population are primarily based on the official definition of urban population. Generally the definition of urban population incorporates local conditions, statistical and methodological conveniences, and a consensus of divergent views on concepts of rural and urban areas.

If the urban/rural definitions are not comprehensive, the resulting urban/rural population may not be adequate to the socio-economic concept of "urban/rural" areas.²⁹ The Indian definition of an urban area is a good example of one incorporating the socio-economic concept of an urban area:

Census towns are determined on the basis of a number of empirical tests: (a) a density not less than 1,000 persons per square mile; (b) a minimum population of 5,000; (c) three-fourths of the working population should be outside of agriculture; and (d) the place should have, according to the superintendent of the State (of the

²⁹Kingsley Davis, Human Society (New York: The Macmillan Company, 1965), pp. 316-317.

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census), a few pronounced urban characteristics, the definition of which, however, leaves room for vagueness.³⁰

When, as is frequently the case in Latin America, for example, the urban definition consists only of characteristics such as "the administrative seat of a district" and/or "a locality containing more than a given number of persons--e.g., 1,500," the resulting rural/urban division may not satisfy the socio-economic concept of urban/rural areas.

There are no such problems in defining the agricultural occupation. Agriculture could very well be the easiest occupation to define. However, the ratio RURAL/ALF may be substantially influenced by the definition of rural population used.

RURAL/ALF Ratios by Economic Levels. The ratio of the rural population to the agricultural labor force indicates the number of rural persons per male agricultural worker. Table 13 (column 5) shows that the ratio RURAL/ALF jumps from 4.6 for economic levels 1 and 2 to 7.0 for economic level 4 in 1960. However, in economic level 3 the ratio is 4.0. Why does the ratio in level 3 deviate from the trend shown in economic levels 1, 2, and 4? We have seen that the proportion ALF and the proportion RURAL consistently decline with a rise in economic level. Why is there no such trend in the case of RURAL/ALF? To answer this question, we must determine how variations in the ratio can occur. The factors affecting the ratio can be divided into two categories: estimation factors and demographic factors.

Estimation Factors. If the rural population and/or agricultural labor force are not correctly estimated, the RURAL/ALF ratio will probably be incorrect--unless, of course, both are in error by the same relative magnitude. Earlier in this section (see above) we showed that the agricultural labor force is usually estimated correctly, and that errors in estimating the rural population are likely to occur because of the criteria used in making the rural/urban dichotomy.

On the basis of the evidence presented,³¹ it appears that the main reason for the low RURAL/ALF ratio in economic level 3 is the underestimation of the rural population in a few of the major countries of that level. Before elaborating on this point,

³⁰ Census of India, 1961 Census. Final Population Totals, Paper No. 1 of 1962, p. xxxvii.

³¹ See p. 54 and footnotes 12, 25, 26 and 28 concerning Mexico, Venezuela, Taiwan, and Spain respectively, all of which belong to economic level 3.

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let us consider why---for demographic reasons---the ratio RURAL/ALF for economic level 3 should be higher than for level 2.

(1) The growth figures of the ALF (1950-60) in the two economic levels are as follows:

	Number of Countries	Total ALF (in 000's) in Countries Cited in Column (1) ^a	Weighted Mean ^b of the Percent Growth of ALF
		1950	1960
	(1)	(2)	(3)
			(4)
Economic Level 2	21	90,602	111,761
Economic Level 3	15	28,226	30,455
			23.35
			7.90

^aThe "totals ALF" are the sums of the weights (w) shown in columns (4) and (5) in Table 14.

^b $\left(\frac{\text{Col. (3)}}{\text{Col. (2)}} - 1 \right) \times 100$. It can be shown that this formula implies that the weights are the sizes of the agricultural labor forces at the initial period (i.e., 1950) in each country.

The ratio of the growth of the ALF between economic levels 2 and 3 is 3:1. Such a difference in growth rates cannot be explained by assuming that the rate of natural increase of the rural populations in the two levels differs by the same ratio. We must assume that there is proportionally more out-migration of ALF than other segments of the rural population in economic level 3 than in level 2. As a consequence, the RURAL/ALF ratio in economic level 3 would be higher than that in level 2.

(2) The RURAL/ALF ratio is affected by the proportion of the farm population within the rural population: FARM/RURAL.³²

³²At first glance this statement may seem to be in conflict with our earlier contention that the concept of rural population should be based partly on the occupational structure in a locality (i.e., on the proportion ALF). However, if the urban definition is as complex as in India, a village may have one-half of its working population engaged in non-farm activities, but still not be classified as "urban," unless it satisfies the other three criteria (see p. 82). For similar reasons we find many "rural" areas in the United States where farming is not the dominant occupation.

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The ratio RURAL/ALF is higher where the FARM/RURAL ratio is lower --i.e., where a higher proportion of the rural population is dependent on non-farm activities. [We cannot use the FARM/RURAL figures shown in Table 13 here, because the accuracy of the data on rural population is the focus of the present discussion. We will have to use indirect reasoning.] Our discussion of FARM/RURAL ratios in economic level 4 and Europe (pp. 70 and 80-81) indicated that the ratio FARM/RURAL tends to be higher where the proportion ALF is higher. Since the proportion ALF in economic level 3 is lower than in level 2, it follows that the ratio FARM/RURAL in level 3 should be lower than in level 2. This leads to the conclusion that the ratio RURAL/ALF in level 3 should be higher than in level 2. But even if we assume, as the "observed" data (Table 13) show, that the FARM/RURAL ratios are the same in both economic levels, the factors discussed in (1) above would produce a higher ratio RURAL/ALF in economic level 3 than in level 2.

On page 62 we demonstrated that in general the proportion RURAL is greater than the proportion ALF in a given country. In a later section (pp. 89-90) we shall show that under the conditions of the quasi-stable population model (and no migration), the ratio RURAL/ALF should be around 3.5 to 3.7. Generally the observed ratios are more than 4.0, however, indicating some out-migration of ALF from the rural areas.

In Appendix Table V (ratios on agricultural populations) we observe that, with very few exceptions, when the RURAL/ALF ratio is less than 4.0, the proportion RURAL is less than the proportion ALF--i.e., the rule of $RURAL/POP > ALF/TLF$ is violated. Following is a list of the countries where the RURAL/ALF ratio is less than 4.0, and the proportion RURAL is less than the proportion ALF:

Bechuanaland	1960
El Salvador	1950, 1960
Guatemala	1960
Mexico	1950, 1960
Nicaragua	1950, 1960
Cuba	1950
Haiti	1950
Colombia	1950, 1960
Taiwan	1950, 1960
Greece	1960
Spain	1950, 1960

As noted, there are some exceptions, such as Algeria, the Dominican Republic, Israel, and Turkey, where the RURAL/ALF ratio is less than 4.0 but the proportion RURAL is greater than the proportion ALF. But there is no country where the proportion RURAL is less than the proportion ALF and the RURAL/ALF ratio is more than 4.0. Consequently, a good criterion for evaluating

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rural population data is that if the proportion RURAL is less than the proportion ALF, the data on rural population are very likely to be underestimated.

Five countries in the list above--Mexico, Colombia, Taiwan, Greece, and Spain--are in economic level 3. The remaining countries (which incidentally have quite small populations) are in economic level 1 or 2. In Brazil, the data are as follows:

	$\frac{\text{RURAL}}{\text{POP}} \times 100$	$\frac{\text{ALF}}{\text{TLF}} \times 100$	$\frac{\text{RURAL}}{\text{ALF}}$
1950	63.89	60.95	4.00
1960	54.96	54.22	4.09

With respect to the ratios in 1960, Brazil only barely escaped being listed among the countries with "possibly underestimated rural population." Because of her huge population, we shall add Brazil to the list of five countries of economic level 3.

The six countries of Mexico, Colombia, Brazil, Taiwan, Greece, and Spain contain 73.4 percent of the total ALF among the 19 countries of economic level 3 for which the ratio RURAL/ALF is computed for 1960 (Table 13, column 5). Therefore, the influence of these countries on the weighted average of RURAL/ALF is substantial. The weighted mean of the ratio RURAL/ALF for the remaining 13 countries of economic level 3 is 4.94. This is at least slightly higher than the mean for economic level 2 (4.65 in 1960). But of course we cannot conclude anything about economic level 3 unless we include the rural populations of the six largest countries in the computations. Let us examine the urban definitions of these countries.³³

(1) Mexico: "Agglomerations of 2,500+." Since this definition is purely statistical, the rural population could be underestimated.

(2) Brazil: "Urban and suburban zones of administrative centers of municipios." This definition, of the "administrative unit" type, is an ambiguous one. It is possible that some "rural" areas are included in the "suburban" areas.

(3) Colombia: "Administrative centers of districts and municipios having population 1,500+." Such a definition could lead to the classification of "rural" areas as "urban" areas.

³³ These definitions are obtained from Davis, World Urbanization 1950-1970, Vol. I, pp. 267-318.

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(4) Taiwan: "Extrapolated to midyear for both dates from XII:1950 and XII:1955 estimates--U.N. Demographic Yearbook, 1964." The method used here is indirect; therefore the rural population could be in error. A reasonable estimate of the rural population can be obtained by analyzing the figures for Taiwan reproduced below from Appendix Table V.

	$\frac{\text{RURAL}}{\text{POP}} \times 100$	$\frac{\text{ALF}}{\text{TLF}} \times 100$	$\frac{\text{FARM}}{\text{RURAL}} \times 100$	$\frac{\text{RURAL}}{\text{ALF}}$
1960	41.46	51.28	127.07	3.30

FARM/RURAL is clearly not likely to be 127.07 percent. The farm population data come from an agricultural census; therefore, it is improbable that the farm population is overestimated. The ratio FARM/ALF is 4.19, which gives us even more confidence in the farm population data. Therefore, the farm population in 1960 --5,870,000 persons, or 55.4 percent of the total population--represents the minimum estimate of the rural population. This proportion (55.4 percent is larger than the proportion ALF (51.28 percent) and hence satisfies the basic rule. Allowing for some non-farm rural population, a conservative estimate of the rural population would be 60.0 percent of the total population, instead of the 41.5 percent shown in Appendix Table V. We had planned to adjust Taiwan's rural population data before the analysis of data by computer but somehow neglected to do so.³⁴

³⁴After this passage was written, my attention was drawn by one of my colleagues, Miss Kwan-hwa Chen, to the fact that the proportion of urban population for Taiwan was estimated at 33.1 percent in 1958 on the basis of the following definition of an urban area:

- (1) A minimum population of between 2,500 and 25,000 in a "town" as classified by the census;
- (2) The town has a main street longer than 100 meters, and 50 percent or more of the buildings on this road are shops;
- (3) The function of the town to neighboring villages is (a) collection of rural products and (b) supplying them with the manufacturing goods.

On the basis of these criteria of an urban area, C.S. Chen and T.H. Sun estimated the proportion of urban population in Taiwan. Another set of estimates, using different criteria, was prepared by Yen-Tien Chang. Both estimates are given below.

Year	Estimates of Percent Urban by:	
	<u>Chen and Sun</u>	<u>Chang</u>
1952	27.4	
1956		25.8
1958	33.1	
1960		26.9
1965		29.4

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(5) Greece: "Communes 2,000+ and 12 multi-communal agglomerations." The use of this definition tends to lead to an over-estimation of the urban population. Greece has a very high ratio of FARM/RURAL--.811--in 1960. The farm population is derived from the household data in the 1960 population census, classified by the occupation of head of household.

(6) Spain: "Urban--included in an urban nucleus of 10,000+ and without regard to municipio boundaries. Semi-urban nucleus of 2,000-10,000." Semi-urban areas may include rural population. Earlier in the text (p. 81) it was suggested that the rural population of Spain might be underestimated. The accuracy of the farm population data for 1960 cannot be determined, since they are based on the FAO's 1965 estimate. However, the 1960 figure seems inconsistent with the farm population size in 1950, which is derived from the 1950 census of population.

This examination of urban definitions confirms the contention that the rural population is underestimated for most of the population living in countries of economic level 3. It also demonstrates that it is possible to evaluate the data on rural population, agricultural labor force, and farm population on the basis of comparative arguments. Precise adjustments would require further investigation in each case. Several cross-checks were made during the data processing; at this stage it would be impossible to reevaluate and adjust every figure. In any case, the agricultural labor force data, which are the primary focus of this study, are sufficiently accurate for our purposes. Inaccuracies in the figures for rural and farm populations will not affect our main analysis.

In Table 15 the RURAL/ALF ratios are shown by geographic subregions. Apart from the subregions containing the 11 countries listed on page 87, the general pattern is consistent with the pattern of the economic levels--i.e., the higher the economic development of a subregion, the higher the ratio RURAL/ALF. The Northern American subregion shows both the highest value in 1960 (13.1) and the greatest change during the decade 1950-60.

(Sources: Chen and Sun, Population Distribution and Change in Taiwan [Taipei: Institute of Agricultural Geography, 1958], p. 23; Chang, Population Growth and Food Production and Consumption in Taiwan [Taipei: The Research Institute of Rural Socio-economics, National Taiwan University, 1967], p. 29.)

Our "estimate" of the proportion of urban population in 1960 (40 percent) is about 10-13 percentage points higher than their estimates.

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A Demographic Interpretation of the Ratio RURAL/ALF

Let us imagine that the rural population is a closed population--i.e., unaffected by migration. Let us further assume that agriculture is the only occupation available in rural areas and that the labor force participation rate is 100 percent (or the same everywhere). Under these conditions the ratio RURAL/ALF will be determined by the fertility and mortality levels of the rural population.

Then the age-distribution of a stable population can be used to determine the ratios RURAL/ALF under different sets of fertility and mortality schedules. (See Table 16.) For a given level of mortality, a rise in fertility increases the ratio RURAL/ALF, and for a given level of fertility, a decline in mortality increases the ratio. But the effect of fertility and mortality changes is not the same. If the Gross Reproduction Rate (GRR) is

Table 16

RATIOS OF THE TOTAL POPULATION (BOTH SEXES) TO THE POPULATION IN AGES 15-59 YEARS (ONE-SEX), FOR THE STABLE POPULATIONS^a

Gross Reproduction Rate	Expectation of Life at Birth (e_0^O) - Years		
	30.0	50.0	70.2
	Ratios: TOT POP/POP 15-59 (One Sex)		
3.0	3.67	3.92	4.13
2.5	3.47	3.71	3.89
2.0	3.28	3.49	3.66
1.5	3.13	3.33	3.47
1.0	3.08	3.29	3.41

^aTo simplify matters, we are assuming that the age distribution is the same for both sexes. Then, on the basis of female stable age distribution, if x is the proportion of females in ages 15-59 years, the required ratio is equal to $(\frac{2}{x})$.

Source: United Nations, The Aging of Populations and Its Economic and Social Implications (ST/SOA/Series A/26), New York: Department of Economic and Social Affairs, 1956, p. 27, Table 16.

reduced by half--from 3.0 to 1.5--and the mortality level is kept constant at e_0^o of 50 years, the ratio declines from 3.92 to 3.33, or by 15.0 percent. If the death rate is reduced by half--from 33.2 to 16.0 (which is equivalent to a change of e_0^o from 30 to 50 years)--and the fertility level is kept constant--GRR at 2.5--the ratio increases from 3.47 to 3.71, or by 7.0 percent.³⁵ Thus the effect of a change in fertility is more pronounced than a change of the same magnitude in mortality. This principle is the basis of the quasi-stable population theory.

It is a well-known fact that the fertility level of a country is negatively associated with its economic level. Therefore, other things being equal, the ratios RURAL/ALF of hypothetical closed rural populations should increase gradually as we move up from economic level 1 to 4. Using somewhat realistic pairs of GRR and e_0^o from Table 16 as examples, economic level 1 can be associated with the ratio 3.67 (GRR = 3.0 and e_0^o = 30) and economic level 4 with the ratio 3.47 (GRR = 1.5 and e_0^o = 70.2). Thus the ratios RURAL/ALF for hypothetical closed rural populations would not differ much between the four economic levels.

The observed ratios RURAL/ALF, however, are considerably larger than those shown in Table 16. The average ratios for economic levels 1, 2, and 3 are about 4.5, and for economic level 4, about 7.0. This is due primarily to (1) proportions of the non-farm population within the rural population and (2) the out-migration of the agricultural labor force (see pp. 84-85).

We can show the importance of non-farm activities under hypothetical conditions. Let us again assume that the rural population is closed to migration. We will also assume that an x proportion of its labor force is engaged in "farm" activities, and that there are no fertility and mortality differentials by occupation. Then,

$$\frac{\text{RURAL}}{\text{ALF}} = \left(\frac{\text{RURAL}}{\text{TLF}} \right) \times \frac{1}{x}$$

In a typical economic level 2 country, the fertility and mortality levels can be approximately represented by a GRR of 2.5 and e_0^o of 50 years. This would produce a RURAL/TLF ratio of 3.71 (Table 16). If we substitute the average observed value of the ratio RURAL/ALF for economic level 2 (Table 13, column 5), we get

$$x = \frac{(\text{RURAL/TLF})}{(\text{RURAL/ALF})} = \frac{3.71}{4.60} = \underline{0.81}$$

³⁵The vital rates corresponding to pairs of GRR and e_0^o are shown in the United Nations publication cited in Table 16.

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In other words, 81 percent of the rural labor force is engaged in agriculture, and because there is no difference in the vital rates, 81 percent of the rural population is farm population (FARM/RURAL). This is very close to the observed value of FARM/RURAL--77.9 percent in 1960 (Table 13, column 3).³⁶ These results may be misleading. In our computations we have assumed that the labor force participation rate is 100 percent for males of ages 15-59 years in rural areas. This may not be so. If we assume that the participation rate is 85 percent (generally the rate is computed for ages 15-65 years), then

$$x = \frac{(\text{RURAL/TLF} \times 0.85)}{(\text{RURAL/ALF})} = \frac{1}{0.85} \times \frac{3.71}{4.60} = \underline{\underline{0.949}}$$

This value of x (FARM/RURAL) is much higher than the observed value. If the observed value of FARM/RURAL (.779) holds, then the agricultural labor force must be reduced (i.e., must migrate to the non-agricultural sector) by 21.8 percent [$(\frac{.949}{.779} - 1) \times 100$].

This procedure has considerable potential value, but it needs refining. It is beyond the scope of this study to perform the necessary tests for each country.

Growth of Agricultural Population

In the preceding sections of this chapter we have described trends of various ratios during 1950-60. A better understanding of such trends requires knowledge of the rates of growth of the population groups in the numerators and denominators of these ratios. An example of this need was given in the model of the decline of the proportion ALF (pp. 65-66). In this section we shall summarize the rates of growth of the various population groups involved in the prior discussion. The rates of growth during 1950-60 of these groups--total population, rural population, total labor force, agricultural labor force, and farm population--are shown in Tables 17 and 18.

Growth of Various Population Groups According to Economic Levels

The relative increase of the total population during the decade 1950-60 is approximately the same for countries in economic levels 1, 2 and 3--about 25 percent. But the increase is much less among the highly developed countries (14 percent--see column 2 in Table 17). This difference between economic level 4 and the

³⁶ If e_0^0 is assumed to be 40 years instead of 50 years, the value of x would be .780 ($\frac{3.60}{4.60}$).

Table 17

WEIGHTED PERCENT INCREASE OF THE TOTAL AND AGRICULTURAL POPULATIONS
ACCORDING TO ECONOMIC LEVELS AND REGIONS: 1950-1960^a
(The sum of weights, w, is expressed in 000's)

Economic Level or Region	Total Population	Rural Population	Total Labor Force	Agricultural Labor Force	Farm Population
(1)	(2)	(3)	(4)	(5)	(6)
Economic Level 1					
$\bar{x}$	26.89	23.52	18.94	19.53	22.72
sd	10.66	9.71	3.13	3.48	8.88
w	297,165	270,639	13,096	11,036	3,889
n	49	49	2	2	2
Economic Level 2					
$\bar{x}$	22.27	16.53	27.14	23.35	11.43
sd	4.66	5.76	6.94	9.75	3.88
w	1,183,000	1,009,290	134,058	90,602	675,844
n	50	50	21	21	7
Economic Level 3					
$\bar{x}$	24.90	9.09	18.91	7.90	1.82
sd	12.70	10.14	10.63	14.23	17.03
w	234,392	141,854	52,719	28,226	50,546
n	27	27	15	15	14

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Table 17 (continued)

(1)	(2)	(3)	(4)	(5)	(6)
Economic Level 4					
$\bar{x}$	14.07	-1.07	9.83	-23.66	-18.41
sd	7.49	7.39	7.97	12.25	12.25
w	772,066	363,491	164,802	40,932	218,779
n	30	30	25	25	21
Africa					
$\bar{x}$	31.03	25.79	21.94	12.93	35.99
sd	12.55	12.33	0	0	16.24
w	155,899	140,032	3,612	1,393	8,320
n	41	41	1	1	4
Middle East					
$\bar{x}$	28.74	19.88	19.67	7.31	8.62
sd	7.02	7.98	9.21	8.10	3.74
w	113,143	85,650	17,831	11,413	6,586
n	22	22	7	7	3
Asia					
$\bar{x}$	21.07	15.49	26.65	20.72	10.38
sd	4.85	7.63	5.94	14.87	5.82
w	1,310,131	1,115,326	150,080	97,621	707,984
n	33	33	11	11	6

Table 17 (continued)

(1)	(2)	(3)	(4)	(5)	(6)
Frontier Countries					
$\bar{x}$	23.60	7.14	15.96	1.14	-15.95
sd	7.69	8.76	9.40	26.67	13.94
w	515,237	261,415	87,379	27,907	132,169
n	35	35	24	24	13
Europe					
$\bar{x}$	8.13	-2.78	6.43	-17.58	-18.29
sd	5.32	7.41	6.69	10.97	13.89
w	392,213	182,852	105,772	32,462	93,997
n	25	25	20	20	18
All Regions					
$\bar{x}$	20.53	13.42	17.83	9.28	4.09
sd	8.81	10.84	11.14	22.20	14.76
w	2,486,623	1,785,275	364,675	170,796	949,058
n	156	156	63	63	44

^aThe rates are weighted by the size of the 1950 population of a country. If P_i and P_i denote populations in 1950 and 1960 respectively, the weighted percent increase of population among "n" countries is $\sum_{i=1}^n \frac{P_i}{n} - 1$ x 100. Therefore, the sum of weights, w, is the sum of given populations in 1950 among given countries in a group. For instance, the value of "w" of 90,602 for economic level 2 in column (5) is the sum of the ALF in 1950 among the 21 countries of economic level 2.

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other three levels is the most important cause of the relatively low growth rates of the other population groups in economic level 4 countries. For example, comparing economic levels 3 and 4, the slower growth of the total labor force in level 4 (about one-half the growth in level 3) is caused mainly by the slower growth of the total population.

Disregarding economic level 1 (because the figures shown in columns 4 and 5 of Table 17 are based on data from only two countries), we find that the proportional difference between the growth of the TLF and the ALF increases as the rate of growth of the TLF declines. This is shown in the following ratios:³⁷

	$\frac{1 + \gamma_1}{1 + \gamma_2}$	γ_2
Economic Level 2	0.9702	27.14
Economic Level 3	0.9074	18.91
Economic Level 4	0.6951	9.83

where γ_1 = percent increase of ALF during 1950-60, and

γ_2 = percent increase of TLF during 1950-60.

The ratio $\left(\frac{1 + \gamma_1}{1 + \gamma_2}\right)$ for economic level 4 is much lower than that for levels 2 and 3. These variations in the relative growth of ALF and TLF are reflected in the decline of the proportion ALF during 1950-60 for different economic levels (see p. 57).

Why should there be such a difference with respect to rates of growth of TLF vs. ALF between economic level 4, on the one hand, and economic levels 2 and 3, on the other hand? There are several reasons; the most important ones can be summarized as follows:

(1) Because of the lower growth rate of the total population among highly developed countries (economic level 4), the growth of TLF in level 4 is also lower;

(2) Because of the higher level of industrialization among the countries in economic level 4 (by definition), the demand for labor from the non-agricultural sector is greater than that for countries in levels 2 and 3;

(3) The demand for labor from the non-agricultural sector in highly developed countries is likely to be greater than the

³⁷Based on data from columns (4) and (5) in Table 17.

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supply of labor provided through natural increase in urban areas. For instance, we note (column (4) in Table 17) that in Europe the total labor force grew by 0.6 percent per year during 1950-60. If the same growth is assumed through natural increase in urban areas (we are ignoring international migration of labor force), the demand for labor from the non-agricultural sector is very likely to be greater than the supply provided through the natural increase in urban areas. The labor deficit is met in several ways. The important ones are: migration of labor from rural areas, higher participation of females in the non-agricultural sector (the preceding discussion of growth of the labor force applies to males only), and shifting of industries to rural areas. The migration of labor from the agricultural sector obviously reduces the growth of the agricultural labor force.

(4) Among the advanced countries, almost by definition, the ALF is a minority group--about 25 percent of the TLF. Therefore, even a moderate pull by the non-agricultural sector would drastically affect the rate of growth of the ALF.

Thus the rate of growth of the total population and the demand of labor from the non-agricultural sector seem to be the major determinants of the growth of the ALF. It is difficult to substantiate this in a cross-sectional static analysis such as ours. In addition, the data on labor demand are not easily available on an international scale. (We shall continue the discussion of the growth of the ALF in Chapter VI.)

Growth of Various Population Groups According to Main Regions

The population figures by regions are also shown in Table 17. Data on the labor force in Africa are available for only one country in 1950 and 1960. In the Middle East and Asia, the growth of the labor force is computed for only one-third of the countries. As we often saw in earlier sections, generalizations are risky for heterogeneous regions at the continent level; the discussion is more fruitful at the subregion level.

Growth of Various Population Groups According to Subregions

The weighted percent increase of population groups during 1950-60 for the subregions are shown in Table 18 (pp. 98-99). As with other factors, the general trend is consistent with the overall economic level of the subregion. The subregions of Northern Africa and Southwest Asia (which together form the Middle East region) are exceptions. (The summary results for Southwest Asia are misleading because they are based on only three countries--Cyprus, Israel, and Turkey--out of a total of 15. These three countries are not typical of the Southwest Asian subregion.)

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Northern America shows the largest decline (39.0 percent) of ALF during 1950-60 of all the subregions.

Middle America displays the largest percent increase of the total population (35.4 percent), and one of the highest growth rates of ALF (28.0 percent), during 1950-60. The moderate growth rate of the rural population (19.7 percent) seems inconsistent with these two figures, but we have already noted irregularities in the estimates of the rural population of Mexico, the largest country in the subregion (pp. 85-86).

The weighted percent increase of labor force in the Caribbean is based on three countries--the Dominican Republic, Puerto Rico, and Trinidad and Tobago. Puerto Rico shows a drastic decline of ALF from 1950-60--about 39 percent. Data are not available for Haiti, Cuba, and Jamaica. Thus a percent decline in ALF of 2.9 during 1950-60 for the Caribbean (column 9, Table 18) is greatly influenced by the data for Puerto Rico.

In Temperate South America the results are considerably influenced by Argentina, the largest country in the subregion. Even though Chile and Paraguay show percent increases in ALF of 11.6 and 29.5 respectively, the weighted growth for the subregion is -0.83 percent because of Argentina's decline in ALF of 9.7 percent during the decade.

The sole East Asian country having data on ALF for both 1950 and 1960 is Taiwan. The decline of ALF in Japan during 1950-60 is at the level of European countries.

Southeast Asia and South Central Asia both show a very high increase--more than 2 percent per year--in total population, rural population, TLF, and ALF.

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Table

WEIGHTED PERCENT INCREASE OF THE TOTAL POPULATIONS AND

Subregion	<u>Total Population</u>		<u>Rural Population</u>	
	n	$\bar{x}$	n	$\bar{x}$
(1)	(2)	(3)	(4)	(5)
Northern Africa	7	26.89	7	18.43
Western Africa	15	40.20	15	33.70
Eastern Africa	13	27.42	13	25.06
Middle and Southern Africa	12	19.94	12	13.56
South Africa [Republic]	1	28.46	1	16.37
Northern America	3	20.01	3	0.35
Middle America	8	35.41	8	19.71
Caribbean	7	24.87	7	18.87
Tropical South America	9	36.26	9	16.80
Temperate South America	5	20.18	5	2.81
East Asia	5	19.81	5	11.94
Japan	1	11.99	1	-8.04
Southeast Asia	13	27.49	13	23.23
Southwest Asia	15	30.31	15	21.10
South Central Asia	8	21.95	8	20.50
Northern Europe	7	4.60	7	-4.93
Western Europe	6	9.18	6	-5.15
Eastern Europe	6	9.33	6	-2.05
Southern Europe	6	8.32	6	-0.96
Australia-New Zealand	2	25.53	2	-6.72
Oceania	6	31.06	6	30.12
U.S.S.R.	1	19.08	1	3.31

^a See the note for Table 17.

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18

AGRICULTURAL POPULATIONS ACCORDING TO SUBREGIONS: 1950-1960^a

<u>Total Labor Force</u>		<u>Agricultural Labor Force</u>		<u>Farm Population</u>	
n	$\bar{x}$	n	$\bar{x}$	n	$\bar{x}$
(6)	(7)	(8)	(9)	(10)	(11)
4	14.53	4	7.90	1	8.60
0	--	0	--	2	29.78
0	--	0	--	2	44.30
0	--	0	--	0	--
1	21.94	1	12.93	0	--
3	9.02	3	-39.04	2	-39.79
8	28.84	8	28.36	1	15.78
3	6.15	3	-2.88	2	-17.93
5	28.87	5	15.27	2	10.15
3	12.57	3	-0.83	3	4.38
1	16.55	1	4.71	3	11.88
1	22.86	1	-20.53	1	-8.64
3	37.31	3	30.86	1	-7.13
3	28.61	3	6.42	1	-8.82
5	26.60	5	24.44	1	11.72
6	4.53	6	-16.35	6	-25.71
6	10.30	6	-25.67	6	-30.34
3	6.91	3	-11.43	1	-2.93
5	3.39	5	-15.99	5	-14.01
2	18.91	2	-2.99	2	3.00
1	12.84	1	35.07	0	--
0	--	0	--	1	-13.03

Chapter IV

AGRICULTURAL LAND

Land and labor are the two key factors in agricultural production. In the preceding chapter, agricultural labor and its associated population groups--farm population and rural population--were discussed in terms of economic levels and geographic regions. In this chapter we shall discuss agricultural land in similar terms. How much land is devoted to agricultural production? What are the predominant patterns of use of agricultural land? What factors determine how agricultural land is used? How does land use vary between countries? These are the pertinent questions that must be answered if we are to understand the relationship between population growth and agricultural land.

Comparability of Arable Land and Pasture

In Chapter II the two main types of agricultural land were described--arable land and pasture. Depending on the availability of data, arable land was subclassified into cultivated land and fallow land, and pasture into cultivated pasture and natural pasture. Beyond this the data on land utilization were not refined for different qualities of land or types of usage between and within countries. It is common knowledge that arable land is not of uniform quality or used with equal intensity in all parts of a given country or in two different countries. Ideally, such differences should be taken account of; this, however is very difficult. J.P. Van Aartsen describes a variety of complex procedures to determine the "agricultural value" of land, "arable equivalents," etc., but such procedures require extensive data.¹

Since 1955, under the aegis of the International Association of Agricultural Economists, work has been progressing on a World Atlas of Agriculture. This atlas, with maps showing 16 different categories of land utilization for each country, should be quite useful in future comparative research on agricultural

¹"Land Classification in Relation to Its Agricultural Value: A Review of Systems Applied," Monthly Crop Report and Agricultural Statistics (International Review of Agriculture), 1944, Nos. 7-8 and 11-12.

lands.² At present, however, the only data available are provided by agricultural censuses and surveys, and "reliable estimates."

As Dovring points out, even such simple procedures as measuring "arable equivalent land" by giving a weight of 1 to arable land, 4 to horticultural land, 0.4 to meadows, and 0.2 to pasture are of little or no value. This is because "even within the conventional category of 'arable land,' differences in natural fertility are so wide, above all because of climatic factors, that data on 'arable equivalent land' have little, if any, advantage over unweighted figures."³ Therefore, we have avoided both complex procedures requiring extensive data and simple ones requiring measures of land qualities within our subclassifications. This makes our conclusions somewhat "tentative," but the magnitudes of possible error involved are less than other types of error inherent in the data (see Chapter II, pp. 30-34).

The Structure of Agricultural Land⁴

The relative magnitudes of the different forms of land utilization for each country in our sample are given in Appendix

²Information is included ranging from "air photographs to topographic, geological, soil, vegetation, forest and other maps." The project is being supervised by the Committee for the World Atlas of Agriculture under the chairmanship of Professor Giuseppe Medici.

³Dovring, Land and Labor in Europe, p. 87.

⁴The description of land use in this chapter is essentially a statistical account of the contemporary world situation. To grasp the full significance of existing patterns of land use in a given country, one should review the history of the country. Such an approach is well illustrated by UNESCO, A History of Land Use in Arid Regions (1961) [NS. 60/III, 211A], edited by L. Dudley Stamp--a fascinating collection of articles describing the evolution of land use in several regions of the world. The purpose of the book is perhaps best expressed in the editor's introduction: "The chapters which follow deal successively with the main regions of arid lands (from which no continent is spared). In each case the author was asked to avoid making his account a mere history of agriculture, but rather to present a synthesis of geological, climatic, biological and human factors which appeared to have influenced the sequence of land use. In particular to know the favourable factors through which men achieved success and prosperity on the one hand or to determine the unfavourable factors which led sooner or later to the

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Table VI; these measures are summarized by economic levels and geographic regions in Tables 19-24 below.

As was explained in Chapter II, the classification of land in a country is limited by the availability of relevant data. For example, there may be data on arable but not on fallow land. This is why the number of countries (n) varies in the different columns of Tables 19 and 22 below. Thirty countries belonging to economic level 1 have data on arable land in 1960, for example, but only seven of these have data on fallow land (see Table 19). Similarly, comparing columns (3) and (5) in Table 22, we find that of 22 countries in economic level 2 for which pasture (total) areas are available in 1960, only eight have data on cultivated pasture.

Agricultural and Arable Land in Relation to Total Land Area

What proportion of the total land area in 1950 and 1960 in the countries under consideration is devoted to agricultural production? What proportion of the land is arable? The weighted proportions of agricultural land (arable + pasture) to the total land area (AGRI/TOT AREA) for the different economic levels and main geographic regions are shown in columns (2) and (3) of Table 19; the proportions of arable land to total land area (ARABLE/TOT AREA) are shown in columns (4) and (5). Table 20 shows the same proportions for matched countries in 1950 and 1960.

Variations According to Economic Levels. One of the most vivid impressions derived from Tables 19 and 20 is of the substantial variations in the ratios (AGRI/TOT AREA and ARABLE/TOT AREA) by economic levels. No useful conclusions can be drawn from weighted averages based on economic levels. The amount of agricultural land in a country appears to be influenced more by geographic and environmental factors than by economic factors. The economic level of a country affects primarily the type of agricultural practices. Thus even though the U.A.R., El Salvador, and India are at the same economic level, the proportion of agricultural and arable land to the total land in these countries is determined mainly by their geographical and environmental conditions.

Table 19 shows that significant improvements in the reporting of agricultural land statistics were made during 1950-60. Thus a comparison between weighted averages of 1950 and 1960 in Table 19 may be misleading. In economic level 2, for example,

abandonment of land cannot but assist in the elucidation of the problems of the present day" (p. 18).

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the percent of agricultural land has not actually declined from 31.16 in 1950 to 22.38 in 1960; rather, a different number of countries is involved in the computations.⁵

For a more realistic indication of the trends during 1950-60, we should turn to Table 20, which is based on matched countries. On the basis of the available data, the countries in level 1 show no significant increase in their proportions of agricultural and arable land during 1950-60. On the other hand, the most advanced countries (economic level 4) register a more than 10 percent increase in both agricultural and arable land during the same period.

It should be pointed out, however, that such a comparison is somewhat misleading, because the countries of economic levels 1 and 2 are not fully represented in Table 20. Matching considerably reduces their number. Further, the increase in agricultural and arable land in the advanced countries is not a widespread phenomenon; we shall see later that arable land declined during 1950-60 in several European countries. Australia is the main contributor to the increase in the weighted proportion of agricultural land in economic level 4.⁶ (A more detailed discussion of changes in the amounts of agricultural and arable land is given in the section on subregions below--pp. 108-110.

Variations According to Geographic Regions. The proportions of agricultural and arable land by main geographic regions are shown in Tables 19 and 20. These geographic regions are as heterogeneous as the economic groups.

On the average, more than one-third of the total land in Africa, Asia, and the Frontier Countries is devoted to agricultural production in 1960 (column (3), Table 19), compared to only one-tenth in the Middle East--due mainly to the vast arid and semi-arid lands in the region. In Europe about 50 percent of

⁵Even though the number of countries reporting data increased from 16 to 22 during 1950-60, the sum of weights--w (i.e., the sum of the total areas of these countries)--declined because China was included in 1950 but not in 1960. Data on pasture (and hence total agricultural land) in China were not available in 1960.

⁶The proportion of agricultural land to total land increased from 48.8 to 60.4 percent during 1950-60 in Australia, an amazing expansion of agricultural land in one decade. The expansion consisted mainly of an increase in pasture of 24 percent. Australia, with a total area of $7,687 \times 10^3 \text{ km}^2$, has a weight of 0.35 ($= 7,687/21,932$) in the weighted ratios of economic level 4 shown in columns (2) and (3) of Table 20.

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Table 19

PROPORTIONS OF TYPES OF AGRICULTURAL LAND ACCORDING TO
ECONOMIC AND GEOGRAPHIC REGIONS: 1950 AND 1960

(Sums of weights, w, are expressed in 1000 km²)

Economic Level or Region	Weighted Means ^a of the Ratios (in percentages) of:					
	AGRI/TOT AREA x 100		ARABLE/TOT AREA x 100		FALLOW/ARABLE x 100	
	1950	1960	1950	1960	1950	1960
(1)	(2)	(3)	(4)	(5)	(6)	(7)

Economic Level 1

$\bar{x}$	49.50	30.31	15.10	8.19	43.02	48.36
sd	18.72	23.12	13.16	9.33	25.05	30.57
w	3,027	8,493	3,979	14,360	312	325
n	12	18	16	30	4	7

Economic Level 2

$\bar{x}$	31.16	22.38	17.12	15.47	22.97	20.12
sd	10.43	19.83	13.67	13.70	12.10	12.12
w	17,198	14,788	22,682	29,723	2,034	2,518
n	16	22	30	38	12	15

Economic Level 3

$\bar{x}$	26.09	30.54	7.03	7.15	30.89	28.56
sd	16.14	19.18	8.73	8.96	16.03	16.50
w	17,149	20,067	17,946	20,155	606	763
n	16	24	21	25	10	12

Economic Level 4

$\bar{x}$	44.58	38.08	8.97	9.97	14.35	14.32
sd	13.71	16.44	8.65	8.27	5.49	6.58
w	21,932	44,334	54,713	54,835	4,076	4,574
n	21	22	26	27	15	16

^aWeights are the values of denominators in the ratios for countries in a group.

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Table 19 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Africa							
$\bar{x}$		42.85	36.81	14.26	9.11	61.26	60.09
sd		21.76	25.85	8.96	9.11	9.03	19.26
w		7,113	12,586	8,408	18,044	299	315
n		13	19	17	32	4	8
Middle East							
$\bar{x}$		13.06	10.16	12.87	7.55	42.30	39.22
sd		0.00	13.21	8.64	8.23	7.70	6.52
w		435	7,422	2,925	8,900	189	504
n		1	9	9	13	5	8
Asia							
$\bar{x}$		33.66	38.32	18.99	19.25	17.94	13.49
sd		9.67	19.74	15.51	14.63	3.67	2.99
w		13,597	5,284	15,788	18,899	1,825	2,007
n		7	10	15	23	4	5
Frontier Countries							
$\bar{x}$		34.08	33.36	6.88	7.66	17.44	17.42
sd		14.79	14.78	5.07	4.82	8.96	9.57
w		34,517	58,108	67,534	68,479	4,106	4,692
n		25	27	29	28	16	15
Europe							
$\bar{x}$		45.63	49.01	30.79	31.28	10.98	9.30
sd		26.10	26.24	16.73	16.89	11.57	10.52
w		3,644	4,281	4,663	4,752	610	662
n		19	21	23	24	12	14
All Regions							
$\bar{x}$		35.59	32.95	10.73	10.65	19.54	18.57
sd		16.30	19.32	10.90	10.55	12.83	13.68
w		59,306	87,681	99,319	119,073	7,029	8,180
n		65	86	93	120	41	50

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Table 20

PROPORTIONS OF TYPE OF AGRICULTURAL LAND ACCORDING TO
ECONOMIC AND GEOGRAPHIC REGIONS FOR COUNTRIES MATCHED
IN 1950 AND 1960

(Sums of weights, w, are expressed in 1000 km²)

Economic Level or Region	AGRI/TOT AREA x 100		ARABLE/TOT AREA x 100		FALLOW/ARABLE x 100	
	1950	1960	1950	1960	1950	1960
(1)	(2)	(3)	(4)	(5)	(6)	(7)

Economic Level 1

$\bar{x}$	60.94	60.91	15.24	15.74	16.18	13.83
sd	9.17	8.78	13.23	13.08	27.86	25.14
w	2,081	2,081	3,906	3,906	105	105
n	8	8	13	13	3	3

Economic Level 2

$\bar{x}$	35.12	37.61	17.37	18.85	19.77	15.76
sd	15.71	16.63	13.81	13.89	5.72	6.09
w	6,506	6,506	21,883	21,883	1,817	1,927
n	11	11	27	27	7	7

Economic Level 3

$\bar{x}$	26.09	29.13	7.03	7.56	30.13	29.04
sd	16.14	16.84	8.73	8.88	16.00	16.12
w	17,149	17,149	17,946	17,946	579	634
n	16	16	21	21	9	9

Economic Level 4

$\bar{x}$	44.58	49.56	8.97	9.96	14.35	14.35
sd	13.71	16.90	8.65	8.27	5.49	6.55
w	21,932	21,932	54,713	54,713	4,076	4,565
n	21	21	26	26	15	15

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Table 20 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Africa							
$\bar{x}$		46.50	49.02	14.27	15.30	63.79	57.28
sd		22.64	25.46	9.22	8.81	17.90	20.59
w		5,749	5,749	7,933	7,933	25	23
n		10	10	16	16	2	2
Middle East							
$\bar{x}$		13.06	17.34	12.87	13.91	47.89	42.12
sd		0.00	0.00	8.64	9.25	11.02	8.94
w		435	435	2,925	2,925	62	83
n		1	1	9	9	3	3
Asia							
$\bar{x}$		46.35	49.60	19.03	20.78	17.94	13.83
sd		10.65	11.17	15.51	15.44	3.67	2.65
w		3,675	3,675	15,744	15,744	1,825	1,909
n		4	4	13	13	4	4
Frontier Countries							
$\bar{x}$		34.27	38.59	6.88	7.75	17.15	17.04
sd		14.74	17.17	5.06	4.82	8.55	9.17
w		34,165	34,165	67,183	67,183	4,056	4,605
n		22	22	26	26	13	13
Europe							
$\bar{x}$		45.63	46.10	30.79	30.98	10.98	9.94
sd		26.10	26.59	16.73	16.90	11.57	10.70
w		3,644	3,644	4,663	4,663	610	610
n		19	19	23	23	12	12
All Regions							
$\bar{x}$		37.35	41.07	10.73	11.73	17.26	16.01
sd		17.67	19.44	10.94	10.91	9.18	9.25
w		47,668	47,688	98,447	98,447	6,577	7,231
n		56	56	87	87	34	34

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the land is under agriculture. Such a high percentage of land utilized for agricultural purposes seems to be an upper limit for industrial societies.

The distribution of arable land among the regions is quite different from that of total agricultural land. In Asia about 19 percent of the total land was arable in 1960, compared to less than 10 percent in Africa and the Frontier Countries (where substantial areas are devoted to pasture) as well as the Middle East. Europe shows the highest proportion of arable land: 30 percent in 1960.

Agricultural land data for the geographic subregions are shown in Table 21. The data available for the regions of Africa improved markedly during 1950-60; consequently, the weighted ratios in Table 21 for these regions in 1950 and 1960 are not strictly comparable. Northern Africa has the lowest proportion of agricultural land--5.8 percent of the total land in 1960--among all the subregions.⁷ The Eastern African subregion shows a higher proportion of agricultural land in 1960 than the Western and Middle and Southern African regions because of extensive agricultural land in Ethiopia (59.3 percent) and Madagascar (65.0 percent). Of the total agricultural land in Africa, only about 8.2 percent is arable in the five subregions (column (9), Table 21).

Except in the Tropical South American subregion, an average of about 40 percent of the land in the American subregions is devoted to agricultural production in 1960. Tropical South America's lower proportion of agricultural land (16.8 percent) is due to the low level in Brazil (17.7 percent) in 1960. In proportion of arable land, the Caribbean (19.3 percent) is substantially higher than the other American subregions in 1960.

In the Asian subregions, the significantly better data coverage for arable land than for agricultural land indicates the relative unimportance of pasture and range lands in Asia. By and large, "agricultural land" and "arable land" are synonymous in Asia. In the East Asian subregion, the level in China, with its high population density, is clearly the greatest influence on the weighted average of arable land for the subregion (12

⁷As Table 3, column (4), and Appendix Table VI show, the weighted average is based on three countries--Algeria, Libya, and Tunisia. The U.A.R. is not included because of the unavailability of data on pasture, which, however, is probably negligible there (see F.A.O., PYB 1965, Table 1). The proportion of arable land in the U.A.R. is 2.4 percent. The effect of the Sahara Desert on this proportion is obvious.

Table 21

PROPORTIONS OF TYPES OF AGRICULTURAL LAND ACCORDING TO GEOGRAPHIC SUBREGIONS: 1950 AND 1960

Subregion	Weighted Means of Ratios (in percentages) of:																				
	AGRI/TOT AREA x 100				ARABLE/TOT AREA x 100				FALLOW/ARABLE x 100												
	n	1950	(3)	(4)	n	1960	(5)	(6)	n	1950	(7)	(8)	n	1960	(9)	(10)	(11)	(12)	n	1960	(13)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)									
Northern Africa	--	--	3	5.84	3	9.59	5	4.35	2	39.59	2	45.24									
Western Africa	5	28.88	6	25.72	6	24.28	13	11.48	2	58.01	5	63.71									
Eastern Africa	4	60.21	6	40.12	6	7.90	9	6.80	--	--	1	6.02									
Middle and Southern Africa	3	23.88	6	29.38	4	19.42	9	8.72	2	71.71	2	55.07									
South Africa (Republic)	1	72.47	1	83.74	1	6.26	1	9.86	--	--	--	--									
Northern America	1	38.76	1	39.29	2	10.26	2	9.70	2	16.34	2	20.03									
Middle America	7	39.82	7	47.40	8	9.68	7	11.46	6	43.67	4	43.19									
Caribbean	5	37.60	6	34.28	6	18.12	6	19.30	1	28.01	1	31.48									
Tropical South America	6	15.02	6	16.76	6	2.60	6	3.31	1	47.17	2	37.96									
Temperate South America	4	43.48	4	45.46	4	7.08	4	6.04	3	38.83	3	40.58									
East Asia	1	29.22	2	21.92	3	10.18	5	12.09	--	--	--	--									
Japan	1	15.97	1	18.07	1	14.15	1	16.36	--	--	--	--									
Southeast Asia	1	14.52	3	14.43	3	12.55	10	12.00	1	18.01	2	10.83									
Southwest Asia	1	13.06	6	16.00	6	16.69	8	13.30	3	47.89	6	37.85									
South Central Asia	1	50.10	2	46.04	4	41.84	5	42.46	3	17.94	3	13.73									
Northern Europe	5	22.41	5	22.40	6	11.14	6	10.66	5	2.48	5	2.97									
Western Europe	6	59.04	6	59.91	6	34.76	6	34.75	2	0.76	3	0.78									
Eastern Europe	5	60.95	5	60.46	6	47.48	6	47.73	3	2.20	3	1.41									
Southern Europe	3	60.82	3	64.32	5	37.70	6	39.37	2	26.13	3	19.86									
Australia-New Zealand	2	48.82	2	60.06	2	1.48	2	1.69	2	29.48	2	21.56									
Oceania	3	13.52	2	17.00	4	4.33	2	4.52	--	--	--	--									
U.S.S.R.	--	---	1	26.84	1	7.51	1	10.15	1	13.04	1	10.71									

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percent in 1960). However, this subregion also contains the extreme example of Mongolia, where only 1.7 percent of the land is arable.

With respect to proportions of arable land, Southeast Asia, Southwest Asia, Japan, and East Asia are similar, but the South Central Asian subregion--the Indian subcontinent--clearly stands apart from the other Asian subregions. About 42 percent of the total land in South Central Asia is arable in 1960, including 49 percent in India and 57 percent in East Pakistan. In view of its large rural population, this subregion has one of the highest levels of arable land utilization in the world.

The countries of the Northern European subregion have widely varying proportions of agricultural and arable land. Denmark has the highest proportion of arable land (64 percent) of all the countries in the world. The United Kingdom has the highest proportion of agricultural land (81.4 percent of the total land in 1960) of all the countries in the world (but the lowest proportion of labor force in agriculture!). In this same subregion, Norway, Finland, and Sweden have less than 10 percent of their land under agriculture.

In the three other European subregions, about 60 percent of the total land is classified as "agricultural" in 1960. The proportion of arable land in these subregions is close to the level in South Central Asia. In Western Europe, only Switzerland has a low level of arable land (10 percent in 1960); otherwise the level ranges from 20 percent in Austria to approximately 30-40 percent in the other countries.

In contrast to Western Europe, the proportion of arable land in Eastern Europe is quite high. In Hungary, for example, 61.3 percent of the land is arable, and in Poland and East Germany about 50 percent.

In Southern Europe, Albania has a low proportion of arable land (16.2 percent in 1960). The highest proportion is in Italy, where 52 percent of the land is arable.

Both New Zealand and Australia have very high proportions of agricultural land (50 and 60 percent respectively in 1960), but only about 2 percent of the land is arable, indicating the importance of pasture in these countries.

Estimates of the Proportion of Arable Land for the World in 1950 and 1960

At the bottom of Table 19 the weighted means for the proportion of arable land (ARABLE/TOT AREA) for the world as a

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whole are shown as 10.73 percent in 1950 and 10.65 percent in 1960. However, these proportions are based on a sample of countries (93 in 1950 and 120 in 1960) which is dependent on the availability of data in the respective years. This means that the world averages could be biased because of differential coverage among regions. We can attempt to eliminate any such bias by using the method applied to estimate the proportion ALF for the world (Chapter III, pp. 63-65). We shall use the geographic regions as the stratified groups because their within-group variance is less than among the economic groups. The adjusted weighted mean for the world would be:

$$\bar{x} = \sum_{i=1}^5 p_i y_i$$

where p_i = proportion of the total land area of the world in region i (shown in the tabulation immediately below) and y_i = the weighted proportion of arable land to the total land in region i (shown in columns (4) and (5) of Table 19).

PERCENT DISTRIBUTION OF THE TOTAL LAND AREA FOR:			
Region	All Countries (p_i)	Sample Countries: 1950 ^a	Sample Countries: 1960 ^a
	(1)	(2)	(3)
Africa	16.38	8.47	15.15
Middle East	10.87	2.94	7.48
Asia	15.41	15.90	15.87
Frontier Countries	53.74	68.00	57.51
Europe	3.60	4.69	3.99
<u>All Regions</u>	100.00	100.00	100.00

^aCountries which have data on arable land.

Sources: Column (1): Chapter III, Table 1; Columns (2) and (3): computed from "w" values in Columns (4) and (5) of Table 19.

This formula for $\bar{x}$ produces estimates of the proportion of arable land to total land in the world of 11.47 percent in 1950 and 10.52 percent in 1960, which leads to the conclusion that there was a decline in the proportion of arable land during the decade 1950-60. However, we think this conclusion is incorrect.

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Our method assumes that the proportion of arable land in the "non-sample" countries is identical to that in the "sample" countries. This assumption is very likely wrong for Africa and the Middle East in 1950, because the proportions of arable land in Africa and the Middle East probably did not decline from 14.26 and 12.87 to 9.11 and 7.55 percent respectively during 1950-60 (columns (4) - (7), Table 19). Thus the "sample" countries in Africa and the Middle East appear to overestimate the level of arable land in these regions in 1950. This overestimation, of course, is the result of the extremely poor coverage of data in 1950 in Africa and the Middle East (compare columns (1) and (2) in the tabulation above). Therefore our method cannot remove the bias resulting from differential coverage in 1950, and though we can state conclusively that the proportion of arable land in the world was 10.52 percent in 1960, we are not yet able to specify the level in 1950. However, we can derive the level in 1950 as follows:

In Table 20 the proportions of arable land for the world are shown as 10.73 percent in 1950 and 11.73 percent in 1960. These proportions are based on data from 87 countries that account for 73.1 percent of the total land area of the world. We shall assume that the trend shown by the data from these 87 countries is representative of the world. Then the proportion of arable land in 1950 which would be comparable to the level of 10.52 percent in 1960 is 9.62 percent ($= \frac{10.73}{11.73} \times 10.52$).

Fallow Land in Relation to Arable Land

An important component of arable land is fallow land. The amount of cultivable land that is not used at a given time is the result of many complex factors: the nature of the land, atmospheric conditions, the supply of land, the demand for agricultural products, the agricultural history of a country, the economic level of a country. Methods of cultivation are often classified by the manner and frequency of letting lands lie fallow. Ester Boserup, for example, identifies the following five types of land-use systems:

- (1) Forest-fallow cultivation: Under this system of land use, plots of land are cleared in the forests each year and sown or planted for a year or two, after which the land is left fallow for a number of years sufficient for the forest to regain the land. This means the fallow period must be at least some twenty to twenty-five years.
- (2) Bush-fallow cultivation: Under this system, the fallow is much shorter, usually somewhere between six and ten years. No true forest can grow up in so short a period,

but the land left fallow is gradually covered with bush and sometimes also with small trees. The period of uninterrupted cultivation under bush-fallow systems varies considerably. It may be as short as one to two years, and it may be as long as six to ten years. Many authors do not distinguish between forest- and bush-fallow systems but show both under the label of long-fallow, or shifting cultivation.

- (3) Short-fallow cultivation: The fallow lasts one year or a couple of years only. In such a short fallow period, nothing but wild grasses can invade the fallow before the cultivator returns to the same plot or field.
- (4) Annual cropping: This is usually not considered a fallow system, but may be classified as such, because the land is left uncultivated, usually for several months, between the harvest of one crop and the planting of the next. This group is meant to include systems of annual rotation, in which one or more of the successive crops are sown with grass or other fodder crops.
- (5) Multiple cropping: This is the most intensive system of land use, since the same plot bears two or more crops every year. The planting of a new crop must therefore take place shortly after the harvesting of the preceding one, and the fallow period is short or even negligible.⁸

The proportion of fallow land to total arable land (= cultivated + fallow land) would be highest under the "forest-fallow" and "bush-fallow" systems--i.e., under the long-fallow systems. (As Boserup notes, these two systems are often referred to as "shifting cultivation" systems in the literature.)⁹ The proportion of fallow land would be much lower under the "short-fallow," "annual cropping," and (especially) "multiple cropping" systems. Properly evaluated, the proportion of fallow land can become a

⁸The Conditions of Agricultural Growth (Chicago: Aldine Publishing Company, 1965), pp. 15-16.

⁹I realize that the description of long-fallow systems provided here is very general and fails to distinguish among a host of specific forms prevailing in different parts of the world. I have paid insufficient attention to the issues of proper terminology. For descriptions of different systems under the "shifting" cultivation" category and a discussion of problems of terminology, see J. E. Spencer, Shifting Cultivation in Southeastern Asia (Berkeley: University of California Press, 1966), pp. 6-10.

useful indicator of the type of cultivation system and intensity of land use.

Boserup has theorized that "the growth of population is a major determinant of technological change in agriculture."¹⁰ According to this thesis, land utilization is a dynamic phenomenon--not a static condition as implied by Malthusian theory. The growth of population forces a community to use land more extensively and intensively. As population pressures increase, and with them the demand for food, a community gradually switches from long-fallow to short-fallow systems of cultivation.¹¹ Since under short-fallow systems previously cultivated land is not left idle for a long period of time (e.g., more than four or five years), some human effort becomes necessary to retain the fertility of the soil. Depending on the natural conditions, this effort may include the use of the plough, the use of manure from animal waste, multiple cropping and crop rotation, irrigation, etc. Boserup provides an elaborate discussion of the interdependence of fallow systems and agricultural techniques.¹²

Changes in agricultural methods are necessarily slow; we cannot expect a direct and immediate "cause-and-effect" relationship. Unforeseen factors such as wars or droughts may upset the process of change, and the dissemination of knowledge gained through new agricultural experiments is slow. Therefore we may find many different farming methods coexisting in the same country.

The Proportion of Fallow to Arable Land According to Economic Level

As we noted in the section on agricultural and arable land, a discussion of patterns of land use based on the economic levels of countries is not likely to be fruitful (p. 102). Agricultural land is closely dependent on geographic factors. Therefore an explanation of the proportions of fallow land by economic levels, as shown in Table 19, necessarily involves the identification of geographic regions. For example, almost half of the arable land in economic level 1 countries lay fallow in 1960 because six of the seven countries are African, and long-fallow systems are predominant in Africa. Economic level 4 shows the lowest proportion of fallow land: 14 percent in 1960. This is

¹⁰ Boserup, p. 56. For a similar view, see Colin Clark, Population Growth and Land Use, Chapter IV.

¹¹ Boserup, pp. 56-64.

¹² Ibid., pp. 24-27.

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the result of two distinct groups of countries in economic level 4--one group consisting of the large countries of Canada, the U.S., Australia ("frontier lands"), and the U.S.S.R.; the other consisting of European countries with an almost negligible proportion of fallow land.¹³

Further examples would serve no useful purpose. Let us proceed to a discussion of geographic regions.

The Proportion of Fallow to Arable Land According to Geographic Regions

A comparison of columns (5) and (7) of Table 19 shows that data on fallow land, in comparison to those on arable land, are very poor for Africa, the Middle East, and Asia. In the Frontier Countries and Europe the situation is better: data on fallow land are available for half of the countries having data on arable land.

Though based on only 50 countries for which data are available for 1960, the FALLOW/ARABLE ratios in Table 19 probably reflect true regional variations. In Africa more than half of the arable land is fallow; this reflects the prevalence of long-fallow systems in Africa. It is interesting to study the variations in population densities among the eight African countries for which data on fallow land are available for 1960:

<u>Country</u>	$\frac{\text{FALLOW}}{\text{ARABLE}} \times 100$	$\frac{\text{RURAL POP}}{\text{ARABLE}}$ (per km ²)
Dahomey	61.4	116.8
Niger	56.7	18.7
Senegal	58.9	43.3
Sierra Leone	98.6	52.5
Togo	66.0	66.0
Kenya	6.0	449.6
Lesotho	8.6	249.3
Central African Republic	64.7	62.7

Sources: Appendix Tables VI and VII.

¹³Since the proportion of 14 for economic level 4 is a weighted average (weights are the amount of arable land in a country), the amount of fallow land in Canada, the U.S., Australia, and the U.S.S.R. greatly influenced the weighted average. The unweighted average of the proportion of fallow land in economic level 4 is 7.17 percent.

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This table may not provide a very accurate representation of Africa. Arable land data for Kenya, Lesotho, and the Central African Republic were obtained from agricultural censuses, and the definitions of fallow land may not be comparable (e.g., the proportion of fallow land in Sierra Leone seems overestimated). Despite the questionable quality of the data, the table shows an interesting correlation. Both Kenya and Lesotho have extremely high RURAL/ARABLE population densities, and they are the only countries with very low proportions of fallow land. These figures support Boserup's contention that high population densities are associated with short-fallow systems.

In a recent work, H.A. Oluwasanmi describes the relationship between population density and fallow systems in Nigeria:

Fallow did not possess the importance which it has now assumed in the farming systems. There was abundant supply of land and the exhaustion and depletion of the fertility of a piece of land would mean its abandonment for a new site. In the less densely populated areas of the country this practice of shifting the farm periodically has not completely disappeared.¹⁴

Marvin Miracle expresses similar views, and specifies three conditions for the existence of a long-fallow system:

Looking at economic development from the beginning of agriculture to the present, we are almost certain to find any tropical economy characterized by shifting cultivation at some early phase of development. It can be expected whenever (1) soil rapidly loses fertility once cleared of natural vegetation; (2) fertilizers are unavailable or expensive; and (3) land is sufficiently abundant, for a given size of population to be supported from it, to permit use of a long fallow. All three of these conditions are characteristic of the Congo Basin and most of the rest of tropical Africa.¹⁵

In the Middle East about 40 percent of the arable land is classified as fallow in 1960 (Table 19). This is a much lower proportion than in Africa, but still twice as much as in the Frontier Countries and three times the level in Asian countries. Europe as a region has the lowest proportion of fallow land--9.3 percent in 1960.

¹⁴ Agriculture and Nigerian Economic Development (New York: Oxford University Press, 1966), p. 48.

¹⁵ Agriculture in the Congo Basin (Madison: University of Wisconsin Press, 1967), p. 33.

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Table 21 gives the FALLOW/ARABLE ratios for the geographic subregions. It shows that the proportion of fallow land in Northern Africa increased from 39.6 to 45.2 percent during 1950-60. However, the data for 1950 and 1960 are not based on the same two countries. The 1950 data are based on Morocco and Tunisia, while the 1960 data are based on Algeria and Libya (see Appendix Table VI). All these countries have much arid or semi-arid land and, in general, lack rain and large rivers; as a result, intensive agriculture is not possible, and dry farming predominates. Hence long-fallow systems prevail, and there is a high proportion of fallow land in this subregion. It should be noted that the most populous country in the subregion--the U.A.R.--is not included in the computations. Probably the main reason for the lack of data on fallow land in Egypt is a general absence of fallow land there. Farming is very intensive in the Nile Valley, where 95 percent of the population lives. The U.A.R. had a RURAL/ARABLE density of 662 per km² in 1960, surpassed only by South Korea and Japan.

In the Northern American subregion the proportion of fallow land is about 20 percent in 1960. However, this is not an indicator of short-fallow cultivation or annual cropping systems in the U.S. and Canada. Their advanced level of agricultural technology and abundance of fertile land make it unnecessary for them to resort to an intensive agricultural system.

In contrast to the Northern American subregion, the other subregions of the Americas have very high proportions of fallow land. Shifting cultivation (long-fallow) systems are prevalent in Latin America, particularly in the tropical region.¹⁶ But this is merely a statement of fact; we must investigate further to determine whether or not the Latin American situation is consistent with the hypothesis of negative relationship between the proportion of fallow land and population density.

Since fallow land is a significant part of the arable land in Latin America, the definition of "fallow land" used is an important factor in determining its extent (see Chapter II, pp. 31-32). There are several definitions used. In Middle America, for example, the definitions vary between countries. The Costa Rican definition includes land lying idle for less than two years. On the other hand, the 1960 census of agriculture in Mexico describes the bulk of fallow land (84 percent) as arable land "lying idle for different reasons." These definitions result in 29.1 percent of the arable land in Costa Rica and 45.7 percent of that in Mexico being classified as fallow. In the Nicaraguan definition of fallow land, the maximum time for land

¹⁶ Miracle, p. 33, and Boserup, p. 15.

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to be idle is five years, and the proportion of fallow land reported in 1960 is 35.7 percent. Clearly these proportions are not comparable. Unless the data are adjusted, it is not feasible to compare the proportions of fallow land with population densities in these countries.

In the Caribbean, data on fallow land are available for only one country--the Dominican Republic--in 1960. This is unfortunate. It would be very interesting to study the data concerning fallow land in this subregion because it is a very densely populated area. Haiti, Jamaica, and Puerto Rico are among the most densely populated countries in the world.

There is also a lack of data on fallow land for the Tropical South American subregion. Data are not available for the largest country in the region (Brazil), and the definitions used by the two countries having data for 1960 are substantially different. The vague definition used in Colombia is quoted in Chapter II above (p. 31). The definition used in the 1961 Census of Agriculture for Peru is "the arable land which has been left idle during July 1960-July 1961 or the land which has been tilled during this time." In the second part of this definition there is a departure from the usual concept of fallow land; perhaps this is why 47.2 percent of the arable land in Peru in 1960 is classified as fallow. The proportion of fallow land in Colombia in 1960 is 31.2 percent. In such a situation, comparisons are meaningless.

Although the information on fallow land in the countries of Temperate South America is good, the data are not comparable. In Chile fallow land is defined as arable land lying idle for less than five years, while in Uruguay the time limit is two years. The definition of fallow land in Paraguay is not provided in its national summary. The difference between the two available definitions must be the main reason for the startling discrepancy in the proportions of fallow land reported: 52.2 percent of the arable land in Chile in 1960 was fallow, compared to 24.1 percent in Uruguay.

This review of definitions should make clear the problem of interpreting figures on fallow land in Latin America. In spite of the incomparability of data, however, we can state that the proportion of fallow land in Latin America is probably around 30-35 percent. This level is certainly lower than in Africa, and higher than in Asia.

The intensive system of agriculture in East Asia is well known; South Korea, Japan, and Taiwan have some of the highest population/agricultural densities in the world (see Chapter V below). However, data on fallow land are not available for this subregion. It is my contention that the main reason for this

lack of data is the absence of fallow systems in the area. Generally, land is not left idle for more than a few months. Deep ploughing and the use of animal manure (including dried fish in Japan) help to maintain the fertility of the soil; extensive irrigation makes multiple cropping possible; rainfall is abundant; and there are fertile river deltas. The East Asia subregion is an extraordinary example of the coexistence of intensive land use and high population densities.

One of the main reasons high population densities are possible in East Asia and Southeast Asia is the prevalence of rice cultivation. J. Beaujeu-Garnier summarizes the relationship between rice consumption and population density:

Rice is one of the most accommodating plants in the world; many different types of soil are suitable, and it is not even hindered by a slight salinity of the water; it likes heat but is grown quite far into the temperate zone where the summer is hot enough; it likes moisture during the period of growth, but dryness at harvest time--and this corresponds exactly to the alternating seasons of the monsoon climate. In certain parts of China as many as three harvests a year are obtained and it is not rare to find rice being harvested throughout the year. The water which floods the paddy-fields often brings with it fertilizing elements, and it is particularly valuable when it is muddy with loess or organic debris, for this solves the problem of maintenance of soil fertility. Another advantage possessed by rice is the size of the yield--it produces two to two-and-a-half times more grain to the acre than wheat, two-thirds more than barley and one-third more than maize. Moreover, it is a food of high value, especially when consumed in the husk; for this external covering of the grain contains four-fifths of the fat, mineral substance and vitamins. Rice is thus the cereal which allows the greatest number of people not to starve on the smallest possible space; and the type of cultivation is one of the main factors in rural population density (in Far-Eastern Asia).¹⁷

A more sophisticated analysis concerning the role of water in rice production--the so-called wet-paddy cultivation system--is provided by Clifford Geertz:

The characteristic thinness of tropical soils is circumvented through the bringing of nutrients onto the terrace by the irrigation water to replace those drawn from the soil; through the fixation of nitrogen by the blue-green algae

¹⁷ Geography of Population (London: Longmans, Green and Company, 1966; translated from the French by S.H. Beaver), p. 55.

which proliferate in the warm water; through the chemical and bacterial decomposition of organic material, including the remains of harvested crops in that water; through the aeration of the soil by the gentle movement of the water in the terrace; and, no doubt, through other ecological functions performed by irrigation which are as yet unknown. . . . The supply of water . . . is the most important aspect of irrigated paddy cultivation; given an adequate and well-controlled water supply the crop will grow in a wide range of soils and in many climates. It is therefore more important than the type of soil.¹⁸

Geertz explains the feasibility of high population density in regions of irrigated paddy cultivation as follows:

Where Swidden [a long-fallow system] "overpopulation" results in a deterioration of the habitat, in a wet-rice regime it results in the support of an ever-increasing number of people within an undamaged habitat. Restricted areas of Java today--for example, Adiwerna, an alluvial region in the north-central part of the island--reach extraordinary rural population densities of nearly 2,000 persons per square kilometer without any significant decline in per hectare rice production. Nor does there seem to be any region on the island in which wet-rice growing was employed effectively in the past but cannot now be so employed due to human overdriving of the landscape. Given maintenance of irrigation facilities, a reasonable level of farming techniques, and no autogenous changes in the physical setting, the Sawah (as the Juwanese call the rice terrace) seems virtually indestructible.¹⁹

The prevalence of multiple-cropping systems in several countries of Asia, the U.A.R., and Australia is shown in the tabulation below. (The list is limited to countries for which the relevant data are readily available.) In order to show that multiple cropping is a response to high population density, the RURAL/ARABLE densities are also given. A perfect mathematical relationship between the two variables cannot be expected because other factors are involved; nevertheless, it is clear that the posited relationship is strong. With the highest population density among the seven countries listed, the U.A.R. also ranks highest in the index of multiple cropping. In Taiwan,²⁰ China,

¹⁸ Agricultural Involution: The Process of Ecological Change in Indonesia (Berkeley: University of California Press, 1963), pp. 29-30.

¹⁹ Ibid., p. 33.

²⁰ The Taiwanese multiple-cropping measure has an upward bias because it is based only on paddy fields.

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Country	Year	$\frac{(\text{Total Cropped Area})}{(\text{Net Cropped Area})} \times 100$	$\frac{(\text{RURAL})}{(\text{ARABLE})}$ (per km ²)
China	1954	135.3	
	1956	142.3	
	1958	145.0	474.2 (1960)
Taiwan	1961	162.6 ^a	427.4 (1960)
India	1951	111.6	188.1 (1950)
	1960	114.7	219.6
West Pakistan	1960	120.0	216.2
East Pakistan	1960	147.9	580.7
U.A.R.	1937	158.3	
	1947	158.6	591.5 (1950)
	1960	175.0	662.1
Australia	1960	104.3	15.3

^aEquals: Area under double cropping paddy +
 $100 \times \frac{\text{Area under single cropping paddy}}{\text{Net area under paddy}}$.

Sources: For computation of index of multiple cropping:
 China: Chao Kuo-Chan, Agrarian Policy of the Chinese Communist Party 1921-1959 (Bombay: Asia Publishing House, 1960), p. 296; Taiwan: Committee on Census of Agriculture, General Report on the 1961 Census of Agriculture, Taiwan Republic of China, p. 4; India: Statistical Abstract of India, 1965, pp. 44-48; Pakistan: Agriculture Census Organization, Pakistan Census of Agriculture, 1960, Vol. I, Final Report East Pakistan, p. 114, and Vol. II, West Pakistan Report No. 2, February 1964, p. 112; U.A.R.: Central Agency for Public Mobilization and Statistics, Basic Statistics, 1964 (Cairo, 1965), p. 13; Australia: Commonwealth Bureau of Census and Statistics of Australia, Primary Industries, Part I, "Rural Industries 1959-60," Bulletin No. 54, February 1962, pp. 2-3.

(RURAL/ARABLE) densities: Appendix Table VII.

and East Pakistan, the three other countries with population densities of more than 425 rural persons per km² of arable land in 1960, the total cropped area is almost 50 percent more than the net cropped area. Next come India and West Pakistan, with moderate levels of both population density and multiple cropping. Finally, there is Australia, which provides a vivid contrast to the other countries.

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The intensity of land use in Egypt is described in the following excerpt from a UNESCO study:

Perennial irrigation meant an extended land use, both horizontally and vertically, to roughly 3 million feddans in 1820 (1000 feddans = 4.2 km²), to 3.5 million in 1830, to 4.1 million in 1852, to 4.9 million in 1889 and, with the completion of the Delta Barrages in 1890, it rose to 5.495 million feddans in 1899, then to 5.658 million in 1911. The actually cultivated area, however, was less: 4.805 million feddans in 1893-1894; 5.403 million in 1904-1905; 5.282 million in 1913. Horizontal expansion has since been slower, the cultivated area being 5.698 million feddans in 1955-56.

Growth of the crop area has been more spectacular. Cropping being year-long, the land now gives two or three crops--sometimes even more--per year. This intensified use is like a change from a vega to a huerta, and makes the farmer rather a gardener. Until the turn of the century, the crop area was nearly 7 million feddans. It reached 8 million in about 1920, 9 million in about 1945 and in 1957 it surpassed the 10-million mark for the first time. The density of cropping is now nearly 177 percent on the national level

Clearly, then, Egyptian agriculture has become intensive as well as truly "wet agriculture." This, however, has been vitiated by many drawbacks inherent in perennial irrigation.²¹

The Southeast Asian subregion is represented by only the Philippines and Thailand in the computation of the FALLOW/ARABLE ratio for 1960. It is unfortunate that the statistical basis is so incomplete because two countries in this subregion--Indonesia and South Vietnam--rank among the ten most densely populated countries in the world. Also, there is very intensive land use in Java and Madura, where two-thirds of Indonesia's population lives.²²

The apparently low level of fallow land (10-20 percent) in Southeast Asia does not necessarily mean that shifting cultivation is not practiced. Spencer points out that "shifting cultivation is practiced in all the humid regions of Southern and Southeastern Asia, from the tidal coasts to the upper limits of crop growth in the higher mountains. Only India and West Pakistan contain areas too arid for the practice of shifting culti-

²¹G. Hamdan, "Evolution of Irrigation Agriculture in Egypt" in Stamp, ed., pp. 127-128.

²²Nathan Keyfitz, "Indonesian Population and the European Industrial Population," Asian Survey, Vol. V, No. 10 (1965), pp. 504-507. Also Boserup, pp. 59-61.

vation."²³ However, using Spencer's own data, we shall show that most of the arable land in Southeast Asia is not under shifting cultivation.

Shifting cultivation or long-fallow systems are usually found in regions having steep slopes, rugged hill country, and forested areas (which are also the low population-density areas). In lowland areas of high population density, short-fallow systems tend to prevail. Spencer describes the transition from shifting cultivation to short-fallow systems in Asia as follows:

Traditionally, throughout much of the Orient, people have been drifting down out of the hills into the lowlands, thus abandoning their former living systems. This locational shift involves the taking on of new cultures, including the acceptance of permanent agriculture. The long-term population dynamics of the lowlands has involved the slow, cyclic, or rapid expansion of permanent settlement, but much of the recent increase has been absorbed on existing lands, rather than splintered off to distant lands, as among the shifting cultivators, until in a few regions the densities have been built up to the point of diminishing returns by permanent agriculture. Here high density is no virtue, for the level of living has been declining. Many permanent agriculturists of the lowlands have shown extreme reluctance to move to new areas at a distance, and their very sedentary state itself is in sharp contrast with the dynamics of shifting cultivators, who often have moved long distances, willfully.²⁴

In the light of these observations, let us examine some pertinent statistics:

PERCENT OF ARABLE LAND UNDER SHIFTING
CULTIVATION: 1960

Country	Land under Shift- ing Cultivation	Arable Land	Percentage:
	(km ²)	(km ²)	(1) (2) × 100
	(1)	(2)	(3)
China	20,234	1,179,090	1.7%
Taiwan	1,416	10,295	13.7
Philippines	9,308	66,990	13.9
Indonesia	68,796	135,386	50.8
South Vietnam	425	23,059	1.8
Thailand	4,856	97,822	5.0
India	56,665	1,609,730	3.5
Pakistan	12,545	232,432	5.4
Ceylon	506	16,916	3.0

Sources: (1) Land under Shifting Cultivation: The sum of "land cleared annually" (and used under shifting cultivation) and "land still harvesting"--as shown in Appendix A in Spencer, p. 174; (2) Arable Land: Appendix Table I, column (4).

²³ Spencer, p. 13.

²⁴ Ibid., p. 16.

If Spencer's estimates of land areas under shifting cultivation are correct (as they probably are, considering his expertise in this field), then only a marginal proportion of the arable land in all the Southeast Asian countries listed here is under shifting cultivation--except in Indonesia. (Perhaps Sabah and Sarawak also have large proportions of arable land under shifting cultivation.)

The Indonesian case is very interesting, because the long- and short-fallow systems coexist equally. This is no doubt partly due to the large concentrations of population on the islands of Java and Madura. The "Swidden" system [long-fallow] prevails in outer Indonesia, and the "Sawah" [wet-paddy] system in inner Indonesia. Geertz comments on the two systems as follows:

The characteristics of Swidden and Sawah as eco-systems are clear and critical: on the one hand a multicrop, highly diverse regime, a cycling of nutrients between living forms, a closed-cover architecture, and a delicate equilibrium; on the other, an open-field, monocrop, highly specialized regime, a heavy dependency on water-born minerals for nutrition, a reliance on man-made water works, and a stable equilibrium. Though these are not the only two traditional agricultural systems in Indonesia, they are by far the most important and have set the framework within which the general agricultural economy of the country has developed. In their contrasting responses to forces making for an increase in population--the dispersive, inelastic quality of the one (Swidden) and the concentrative, inflatable quality of the other (Sawah)--lies much of the explanation for the uneven distribution of population in Indonesia and the ineluctable social and cultural quandaries which follow from it.²⁵

Geertz observes that shifting cultivation is not necessarily an inefficient system of production. He quotes from H. Conklin's field studies on the Philippines, which show that as many as forty different crops can grow simultaneously on a three-acre "Swidden" plot.²⁶

In South Central Asia the proportion of fallow land declined from 17.9 percent in 1950 to 13.7 percent in 1960. This 30 percent decline seems a logical response to the continuously increasing demand for agricultural products in this region. Because of the extensive amount of arable land in India, the weighted proportions of fallow land underscore a great disparity between India and West Pakistan on the one hand, and East Pakistan

²⁵Geertz, pp. 36-37.

²⁶Ibid., pp. 18-19.

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on the other. The following figures are reproduced from Appendix Table VI:

	<u>(FALLOW/ARABLE) × 100</u>	
	<u>1950</u>	<u>1960</u>
India	19.03	14.32
West Pakistan	15.25	14.04
East Pakistan	1.46	1.44

These figures combined with the RURAL/ARABLE population densities for these countries (see p. 121) clearly indicate a strong positive relationship between the proportion of fallow land and population density. In terms of pressure for use of arable land, East Pakistan is more akin to East Asia than to India and West Pakistan.

With the exception of Southern Europe, fallow land is almost non-existent in Europe. The proportions of fallow land are less than one percent of the arable land in such countries as Denmark, Belgium, the Netherlands, and Romania. The intensive agricultural systems used are perhaps the main reason that data on fallow land are not available for half of the countries in the Northern, Western, and Eastern European subregions that have data on arable land.

We have seen that fallow land proportions are insignificant in East and Southeast Asia, and in Northern, Western, and Eastern Europe. How do the population/agricultural densities in these regions compare? Detailed comparisons of various densities in these regions will be given in Chapter V; here we shall be concerned only with the following figures (1960):

<u>Subregion</u>	^a <u>($\frac{\text{RURAL}}{\text{ARABLE}}$)</u>	^b <u>($\frac{\text{RURAL}}{\text{TOT POP}}$)</u>	^c <u>($\frac{\text{TOT POP}}{\text{ARABLE}}$)</u>
	(1)	(2)	(3)
East Asia	487.9	.8237	592.3
Southeast Asia	437.7	.8401	521.0
Northern Europe	186.1	.2763	673.5
Western Europe	182.7	.3196	571.6
Eastern Europe	109.0	.5162	211.2

^aWeighted densities of the subregions; weights are the size of the total rural population of the countries in a subregion.

^bWeighted proportions of the rural population; weights are the size of the total population of the countries in a subregion.

^cObtained by dividing column (1) by column (2).

Sources: ($\frac{\text{RURAL}}{\text{ARABLE}}$): Table 25, Chapter V; ($\frac{\text{RURAL}}{\text{TOT POP}}$): Table 8, Chapter III.

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If the RURAL/ARABLE ratio is used as a measure of population pressure on land, there is certainly much more pressure in East Asia than in Europe. But in the context of land versus demand for food, RURAL/ARABLE is not a good comparative measure because of different degrees of urbanization. Therefore, to show the pressure on arable land, we have computed TOT POP/ARABLE ratios (column (3) in the tabulation above). Here the difference between the Asian regions and Northern and Western Europe is much less than shown by the RURAL/ARABLE ratios. The population pressure on arable land in Northern and Western Europe seems as high as in East Asia. From this, one might conclude that the extremely low proportions of fallow land in these regions are logically necessary. But this kind of comparison between Europe and Asia might be criticized on the grounds that "arable" lands are not comparable, for in Europe pastures are an important source of food supply, while--as we shall attempt to show in the section following--in Asia pastures are insignificant. In such circumstances the TOT POP/ARABLE ratio would tend to overestimate the pressure on agricultural land in Europe. To meet this criticism, we will add "cultivated pasture" to "arable land" in Europe; the sum will be called "cultivated land." We then obtain the following results for 1960:

	$\left(\frac{\text{RURAL}}{\text{CULTIVATED}}\right)^a$	$\left(\frac{\text{TOT POP}}{\text{CULTIVATED}}\right)^b$
Northern Europe	85.2	308.4
Western Europe	153.4	480.0
Eastern Europe	97.9	189.7

^aSum of arable land and cultivated pasture.

^bComputed by using the proportions of the rural population in the respective regions.

By the addition of cultivated pasture to arable land, the European densities are considerably reduced--particularly in Northern Europe, where the reduction is more than 50 percent. The TOT POP/CULTIVATED densities in Northern and Western Europe are now less than the TOT POP/ARABLE densities in the Asian regions. The addition of cultivated pasture makes the TOT POP/CULTIVATED density in Northern Europe (308.4) only about one-half of the TOT POP/ARABLE density in East Asia (592.3). Europe has several other advantages over Asia in this situation. For example, because of a much higher level of urbanization, the average size of agricultural holdings is larger in Europe. This, coupled with more advanced agricultural technology, ensures a higher level of arable land productivity. (The productivity figures are shown in Chapter VI, Tables 34, 35, and Appendix Table VIII.

In this discussion of densities in Europe, we have avoided reference to Eastern Europe, where the TOT POP/CULTIVATED density

is about one-half of that in Western Europe. Here we are primarily concerned with proportions of fallow land; population densities will be discussed in Chapter V. That the proportion of fallow land should be the same in Eastern and Western Europe, even though the population density in Eastern Europe is much less than in Western Europe, is a very puzzling phenomenon. The proportion of fallow land in Eastern Europe is based on data from three countries: East Germany, Hungary, and Romania. The largest country in the region--Poland--and Bulgaria and Czechoslovakia are not included. Perhaps the absence of data on Poland significantly affects the measure of fallow land in Eastern Europe.

In comparison to the other parts of Europe, Southern Europe has a much higher proportion of fallow land--about 20.0 percent in 1960.²⁷

Estimates of the Proportion of Fallow Land in the World in 1950 and 1960

In Table 19 the weighted proportions of fallow to arable land (FALLOW/ARABLE) for "All Regions" are shown as 19.54 percent in 1950 and 18.57 percent in 1960. However, these figures are biased by the excessive influence of the FALLOW/ARABLE proportions of the Frontier Countries and Europe. In other words, the distributions of arable land by regions, as shown by the entries in columns (6) and (7) of Table 19, are biased. (The distribution of arable land can be computed by using the "w" values.) The discussion in the preceding section has established that the proportions FALLOW/ARABLE indicated for 1950 and 1960 by regions (Table 19) probably accurately reflect the regional variations and trends during 1950-60. This is despite the fact that the coverage of statistics on fallow land is very poor for Africa, the Middle East, and Asia. Thus, if we are to improve our estimates of the proportion of fallow land in the world, we need an unbiased measure of the distribution of arable land by regions in 1950 and 1960.

²⁷ This level is based on data from three countries (see Table 21, columns (12)-(13)), but the data for Portugal are very likely erroneous. In 1960 the proportion of fallow land in Portugal is 1.9 percent, in contrast to 24.9 percent in Spain and 13.4 percent in Greece. This discrepancy prompted me to reexamine the figures. The published data on land utilization in Portugal are based on estimates prepared by a private group. Due to an error on my part, the land classified as "uncultivated but productive" was mistakenly labeled as "fallow." Therefore, in the FALLOW column in Appendix Table VI, -- (i.e., no data) should be entered for Portugal.

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We have seen that the coverage of data on arable land improved greatly during 1950-60 (see p. 111 and columns (4) and (5) in Table 19). It is difficult to correctly determine the distribution of arable land by regions in 1950; however, because of the excellent coverage in 1960, we can safely assume that the distribution of arable land indicated in 1960 is very close to the actual distribution. We can compute the weighted proportions of fallow land in 1950 and 1960 by assuming that the proportions of arable land by regions are the same in 1950 as in 1960.²⁸

	Distribution of Arable Land	(FALLOW/ARABLE) (Percentages)	
	<u>1960</u> (<u>p_i</u>)	<u>1950</u> (<u>y_i</u>)	<u>1960</u> (<u>y_i</u>)
	(1)	(2)	(3)
Africa	.1296	61.26	60.09
Middle East	.0530	42.30	39.22
Asia	.2868	17.94	13.49
Frontier Countries	.4135	17.44	17.42
Europe	.1171	10.98	9.30
<u>All Regions</u>	1.0000		
Total Arable Land	12,685,000 km ²		

On the basis of these assumptions, the weighted proportion of fallow to arable land would be computed as follows:

$$\bar{x} = \sum_{i=1}^5 p_i y_i$$

where p_i = the proportional distribution of arable land in 1960 (shown in column (1) above) and y_i = the percent of fallow to arable land in region i (shown in columns (2) and (3) above). The absolute figure for arable land for a region is obtained by computing $\left(\frac{\bar{x}}{w}\right)$ from column (5) in Table 19.

Using this formula we obtain weighted proportions of fallow to arable land for the world of 23.82 percent in 1950 and 22.02 percent in 1960. This means that the proportion of fallow land in the world declined by about 8 percent during 1950-60.

²⁸This assumption implies that the changes in arable land during 1950-60 were uniform in all the regions. We earlier estimated that the proportions of arable land to total area in the world are 9.62 percent in 1950 and 10.52 percent in 1960 (p. 112).

(These revised estimates are about four percentage points higher than those based on the available data for 1950 and 1960.)

Pasture Area as a Component of Agricultural Land

The maintenance of livestock, or the "domestication of animals," is an important part of agricultural activities. Livestock are raised for products such as milk, meat, leather, and wool, and in many less developed countries they are the major source of draft power.

When animals are fed mainly on grass, the meat they furnish does not add much to the total food supply--in either calories or proteins. Animal foods are most nourishing when livestock are fed on roots, cereals, and vegetables--i.e., a diet that is balanced in nutritional content.²⁹ Although animal proteins are richer than those obtained from vegetables and cereals, there is a considerable loss of food when meat is obtained by fattening animals, because energy is lost during the conversion of plants into meat. This point is made by one commentator as follows:

The caloric requirements of a moderately active man can be supplied for a period of one year by the sugar produced on a fraction of an acre of sugar beets. These same energy requirements can be met by slightly less than an acre used to produce apples, wheat or beans, while larger acreages are required with livestock products. It takes around 7.5 acres for feed crops plus 2.3 acres of pasture to produce enough dressed beef to provide the annual food-energy requirements of a moderately active man. This makes beef one of the most expensive foods from the standpoint of land requirements. Among the cereals, wheat is most expensive. This explains why wheat is usually displaced in heavily populated areas by rice or potatoes or by crops such as oats and rye which yield more grain per acre, particularly on the less fertile lands.

The high emphasis placed on livestock products in the diets of the Western world means that a large area must be used for feed crops, pasture, and range. In areas of high population pressure, this could represent a wasteful practice because crops fed to livestock lose 80 to 90 percent of their food value before they re-emerge as meat, milk, or eggs.³⁰

²⁹ Food and Agricultural Organization and the European Association for Animal Production, Problems of Animal Feeding in Europe, F.A.O. Agricultural Development Paper No. 51 (Rome, June 1955), pp. 38-96.

³⁰ Raleigh Barlowe, Land Resource Economics (Englewood Cliffs: Prentice-Hall, 1958), p. 74.

Similar considerations are implied in the computation of "arable equivalent land," where arable land is assigned a weight of 1, horticulture land 4, meadows 0.4, and pasture 0.2 (see p. 101).

However, it would not be desirable--or feasible--to convert all pasture into arable land, as the following description of the interdependence of livestock and arable land makes clear:

Although mechanization and modern agricultural science may eventually push the boundary of cultivated areas far beyond present limits, there will still remain areas of grasslands and woodlands, which would be unproductive unless used for animal production. Moreover, cattle and buffalo are important for draught purposes, especially in cultivated land areas, and are likely to be part of the agricultural scene for a long time to come. Through the return of dung, animals contribute to the maintenance of soil fertility and, in many areas, mixed animal pasture and crop production has been found to be the most economical way to maintain productivity.³¹

Other factors could be considered in comparing the food-producing capacities of pasture and arable land, but for the sake of argument let us assume that more agricultural land is needed to supply food for a non-vegetarian population than for a vegetarian population of equal size. Consequently, as long as industrial inputs do not play a major role in the agricultural system, a society faced with continuous population growth would gradually convert pasture (particularly cultivated pasture) into arable land. This change would be in addition to (or coincide with) the increasingly intensive use of existing arable land. As noted, this process would not necessarily mean that livestock would eventually be eliminated in very densely populated areas.

Depending on the stage of evolution of land use and population growth, pasture would be subject to different kinds of pressures. During the early stages, in response to an increasing demand for livestock products, the proportion of cultivated pasture would be increased. However, since not all natural pasture can be converted into cultivated pasture (for geographic reasons), an upper limit on the amount of cultivated pasture would be reached. If the population continued to grow at a high rate, it would become increasingly difficult to maintain the per capita consumption of meat products. Eventually the amount of arable land would have to be increased at the expense of cultivated pasture. This would increase the proportion of arable land to

³¹C.S. Christian, "The Use and Abuse of Land and Water" in Larry K.Y. Ng, ed., The Population Crisis (Bloomington: Indiana University Press, 1965), p. 165.

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total agricultural land and decrease the proportion of cultivated pasture to total pasture.

We are led by these considerations to two general hypotheses:

- (1) The proportion of pasture to agricultural land will be lower in the countries with higher population densities;
- (2) The proportion of cultivated pasture will have a uni-modal relationship to population density; the proportion will rise with the density until it reaches a modal density, and then decline with increase in population density.

In interpreting data we must take note of biases in data reporting. In countries where pasture is not a significant proportion of the total agricultural land, we may not find any data on pasture in the land-classification tabulations. For example, by comparing column (5) of Table 19 with column (3) of Table 20, we find that among the 23 Asian countries providing data on arable land, only nine also provide data on pasture. On the other hand, of 28 "Frontier Countries," 26 give data on pasture. A similar bias regarding information on cultivated pasture may exist among the countries having data on total pasture.

Pasture Areas According to Geographic Regions

The extent of pasture areas in the different regions of the world can be estimated from the weighted proportions of arable land to total agricultural land--ARABLE/AGRI--shown in columns (2) and (3) of Table 22. If data on pasture were available for all countries having data on arable land, then ARABLE/AGRI ratios could have been obtained from the ARABLE/TOT AREA and AGRI/TOT AREA ratios given in Table 19. Let us compare the ARABLE/AGRI figures for regions derived from the two different tables (19 and 22):

	$\left(\frac{\text{ARABLE}}{\text{AGRI}}\right) \times 100^a$	$\left(\frac{\text{ARABLE}}{\text{AGRI}}\right) \times 100^b$
	1960	1960
	(Observed)	(Estimated)
Africa	24.85	24.75
Middle East	73.60	74.31
Asia	91.82	50.23
Frontier Countries	25.14	22.96
Europe	60.41	63.82

^aFrom column (3), Table 22.

^bObtained by: $\frac{\text{ARABLE/TOT AREA (Column (5), Table 19)}}{\text{AGRI/TOT AREA (Column (3), Table 19)}}$

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Table 22

PROPORTIONS OF TYPES OF AGRICULTURAL LAND ACCORDING TO
ECONOMIC LEVELS AND GEOGRAPHIC REGIONS: 1950 AND 1960^a

(Sums of weights, w, are expressed in 1000 km²)

Economic Level or Region	Weighted Means of the Ratios (in percentages) of:			
	ARABLE/AGRI x 100		CULT PASTURE/ TOT PASTURE x 100	
	1950	1960	1950	1960
(1)	(2)	(3)	(4)	(5)

Economic Level 1

$\bar{x}$	30.39	20.64	--	1.92
sd	33.30	26.88	--	0.00
w	1,488	2,511	--	404
n	11	16	--	1

Economic Level 2

$\bar{x}$	60.49	85.71	49.39	20.98
sd	29.53	17.58	22.10	24.80
w	5,340	3,310	16	100
n	15	22	2	8

Economic Level 3

$\bar{x}$	22.47	22.84	14.19	10.36
sd	13.59	16.82	7.48	7.88
w	4,475	6,128	1,594	3,761
n	16	24	9	15

Economic Level 4

$\bar{x}$	27.62	29.03	10.06	8.19
sd	24.73	19.90	14.03	12.24
w	9,777	16,882	6,139	8,119
n	21	22	13	14

^aExtension of Table 19.

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Table 22 (continued)

	(1)	(2)	(3)	(4)	(5)
Africa					
$\bar{x}$		35.90	24.85	--	0.54
sd		37.22	32.56	--	0.74
w		3,048	4,633	--	1,837
n		13	19	--	3
Middle East					
$\bar{x}$		95.94	73.60	--	5.78
sd		0.00	21.00	--	3.46
w		57	754	--	68
n		1	9	--	4
Asia					
$\bar{x}$		57.40	91.82	--	23.75
sd		28.92	5.92	--	3.31
w		4,558	1,972	--	1
n		6	9	--	2
Frontier Countries					
$\bar{x}$		22.04	25.14	8.57	8.43
sd		17.56	15.51	9.27	8.51
w		11,754	19,374	7,246	9,779
n		24	26	11	15
Europe					
$\bar{x}$		62.14	60.41	45.74	35.01
sd		17.09	17.13	12.41	18.52
w		1,663	2,098	504	699
n		19	21	13	14
All Regions					
$\bar{x}$		35.05	33.49	10.99	8.75
sd		29.10	27.45	13.20	11.21
w		21,080	28,831	7,749	12,384
n		63	84	24	38

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The difference between the two proportions is a function of the proportion of arable land to total area (ARABLE/TOT AREA) in the countries providing data on arable land but not on pasture. Except for Asia, the two sets of figures are remarkably close. This is to be expected for the Frontier Countries and Europe, because proportionally very few of the countries in these regions having data on arable land do not have data on pasture.

The reason for the large difference between the two estimates of ARABLE/AGRI ratios for Asia is that 13 countries in Asia have statistics on arable land but not on pasture in 1960. The weighted proportion of ARABLE/TOT AREA among these 13 countries is much lower than the proportion based on all 23 countries which have data on arable land in 1960 (see column (5) of Table 19)--19.25 percent--because China, with a 12.1 percent ratio, is one of the 13 countries with no data on pasture in 1960. The huge dimensions of China inevitably lower the weighted proportion ARABLE/TOT AREA for these 13 countries below 19.25 percent.

According to the available data, more than 90 percent of the agricultural land in Asia in 1960 is arable land--i.e., pasture is less than 10 percent of the total agricultural land. On the other hand, only one-fourth of the agricultural land in Africa and the Frontier Countries is arable, while in Europe, 60 percent of the agricultural land is arable. Thus, on a very general level, proportions of arable land (= 1 - proportion of pasture) are positively related to population densities, which lends support to hypothesis (1) on page 131.

When countries are matched for availability of arable land and/or pasture data in 1950 and 1960 (Table 23), the number of countries for the Middle East and Asia is very small. There seems to be virtually no change in the ARABLE/AGRI ratios during 1950-60; the most pronounced change is in the Frontier Countries, where the proportion declined by about 13 percent.³²

³²In view of the high population growth rates in Latin American countries during 1950-60, this decline in the proportion of arable land may seem to conflict with the hypothesis that continuous population growth would tend to reduce the proportion of pasture (p. 131). However, it should be borne in mind that the hypothesis assumes the prevalence of traditional agricultural methods, and that the Frontier Countries region is very heterogeneous, consisting of traditional agricultural countries in Latin America (except Argentina) on the one hand, and advanced countries like the U.S. and Australia-New Zealand on the other. In Table 24 we can see that the decline in the proportion of arable land is confined mainly to Northern America (U.S.), Temperate South America, and Australia-New Zealand. In these areas, because of the very high productivity of arable land, pastoral activities are much more

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In Table 24, the ratios relating to pasture are shown according to geographic subregions. In Northern Africa, about one-half of the agricultural land is pasture; however, this is not the kind of pasture found in the Frontier Countries, for Northern Africa is an arid zone.

Northern Africa, or the Magurib, which includes Morocco, Algeria, and Tunisia, is adjacent to Sahara, which is the largest and driest of the world's deserts. While it is not itself desert land, four-fifths of its area lie in more or less arid zone, and it marks the transition to the countries with a definitely Mediterranean climate.³³

The nomadic nature of populations in arid zones is well known; herds of sheep and goats are moved from one place to another as dictated by climate, altitude, and water supply. Goats in particular are known for their great agility and their capacity to move on rugged terrain and survive on scarce grass. In such regions, the delimitation of pasture is very difficult, and the degree of intensity of use of grass lands is certainly less than that found in Northern America and Western Europe. Because of the uncertain definition of pasture in such areas, some data on pasture in this and other arid regions were rejected (see Chapter II, p. 33). For example, an area of 380,050 km² in Algeria is designated as "largely rough grazing," compared to 70,660 km² of arable land.³⁴ Therefore, such proportions of arable land to total agricultural land as 55.6 percent in Northern Africa in 1960 and 82.5 percent in Western Africa in 1950 (the other important arid zone) are very likely to be biased because of the unreliability of available data.

In Western Africa, the weighted averages of ARABLE/AGRI show a drastic decline from 88.7 percent to 35.1 percent during 1950-60. Obviously this is because most of these countries are unmatched in 1950 and 1960.³⁵

profitable than growing cereals and crops. (The subsidization of cropland in the U.S. is a case in point.)

³³J. Despois, "Development of Land Use in Northern Africa" in Stamp, ed., p. 219.

³⁴F.A.O., Production Yearbook 1965, Table 1.

³⁵As we can see from Appendix Table VI, there are only three countries--Liberia, Sierra Leone, and Togo--which provide the necessary data for both 1950 and 1960. At the same time, the weighted ratios are based on five and six countries respectively in 1950 and 1960 (Table 24). The weighted average in 1960 is heavily influenced by the ARABLE/AGRI ratio (0.67 percent) in Mauritania. The quality of data from Mauritania is "unknown," and perhaps should not have been included in the analysis.

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Table 23

PROPORTIONS OF TYPES OF AGRICULTURAL LAND ACCORDING TO
ECONOMIC LEVELS AND GEOGRAPHIC REGIONS FOR COUNTRIES
MATCHED IN 1950 AND 1960^a

(Sums of weights, w, are expressed in 1000 km²)

Economic Level or Region	Weighted Means of the Ratios (in percentages) of:			
	ARABLE/AGRI × 100		CULT PASTURE/ TOT PASTURE × 100	
	1950	1960	1950	1960
(1)	(2)	(3)	(4)	(5)
Economic Level 1				
$\bar{x}$	18.87	18.93	--	--
sd	20.77	20.38	--	--
w	1,258	1,257	--	--
n	7	7	--	--
Economic Level 2				
$\bar{x}$	93.83	91.03	49.39	48.05
sd	8.18	10.29	22.10	25.18
w	2,285	2,447	16	15
n	11	11	2	2
Economic Level 3				
$\bar{x}$	22.47	21.85	14.19	16.28
sd	13.59	13.36	7.48	7.20
w	4,475	4,995	1,594	1,777
n	16	16	9	9
Economic Level 4				
$\bar{x}$	27.62	24.16	10.06	9.19
sd	24.73	23.42	14.03	12.63
w	9,777	10,870	6,139	7,215
n	21	21	13	13

^aExtension of Table 20.

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Table 23 (continued)

	(1)	(2)	(3)	(4)	(5)
Africa					
$\bar{x}$		30.59	30.80	--	--
sd		35.42	34.12	--	--
w		2,673	2,818	--	--
n		10	10	--	--
Middle East					
$\bar{x}$		95.94	99.06	--	--
sd		0.00	0.00	--	--
w		57	75	--	--
n		1	1	--	--
Asia					
$\bar{x}$		94.58	91.71	--	--
sd		5.25	4.27	--	--
w		1,703	1,823	--	--
n		4	4	--	--
Frontier Countries					
$\bar{x}$		21.98	19.22	8.57	8.63
sd		17.45	15.57	9.27	8.80
w		11,698	13,173	7,246	8,487
n		21	21	11	11
Europe					
$\bar{x}$		62.14	61.75	45.74	43.57
sd		17.09	18.41	12.41	13.19
w		1,663	1,680	504	520
n		19	19	13	13
<u>All Regions</u>					
$\bar{x}$		34.21	31.60	10.99	10.65
sd		30.87	29.95	13.20	12.22
w		17,794	19,569	7,749	9,007
n		55	55	24	24

Table 24

PROPORTIONS OF TYPES OF AGRICULTURAL LAND ACCORDING TO GEOGRAPHIC SUBREGIONS: 1950 AND 1960 ^a									
Subregion	Weighted Means of Ratios (in percentages) of:								
	ARABLE/AGRI x 100				CULT PASTURE/TOT PASTURE x 100				
	n	1950	(3)	(4)	n	1960	(6)	(7)	(8)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
Northern Africa	--	--	3	55.59	--	--	2	3.72	
Western Africa	5	88.73	6	35.11	--	--	--	--	
Eastern Africa	4	15.14	6	19.81	--	--	--	--	
Middle and Southern Africa	3	81.64	6	33.48	--	--	2	0.84	
South Africa (Republic)	1	8.64	1	11.77	--	--	1	0.23	
Northern America	1	45.27	1	41.02	1	14.07	1	12.11	
Middle America	7	25.11	7	24.18	3	45.25	4	54.46	
Caribbean	5	49.97	6	56.30	1	69.21	2	62.75	
Tropical South America	6	17.32	6	19.74	2	13.69	3	15.52	
Temperate South America	3	17.86	3	14.41	2	5.87	3	6.65	
East Asia	1	35.18	2	99.02	--	--	1	31.82	
Japan	1	88.60	1	90.52	--	--	--	--	
Southeast Asia	--	--	3	91.66	--	--	--	--	
Southwest Asia	1	95.94	6	82.47	--	--	2	10.64	
South Central Asia	1	95.12	1	92.00	--	--	--	--	
Northern Europe	5	47.19	5	45.25	5	51.86	5	52.42	
Western Europe	6	58.88	6	58.00	4	46.64	4	42.63	
Eastern Europe	5	74.34	5	75.66	3	41.14	3	38.29	
Southern Europe	3	66.46	5	60.31	1	31.05	2	15.14	
Australia-New Zealand	2	3.04	2	2.81	2	3.88	2	4.50	
Oceania	3	33.39	2	26.59	--	--	1	22.39	
U.S.S.R.	--	--	1	37.81	--	--	--	--	

^aExtension of Table 21.

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The quality of data on agricultural land in general, and on pasture in particular, is very poor in Africa. There are few agricultural censuses. In Eastern Africa, only Kenya provides data on pasture through an agricultural census, reporting 70.0 percent of the agricultural land as pasture. On the other hand, the "official" estimates of Madagascar put this percentage at 96.4 in 1960. In such a situation, it becomes impossible to detect any trend.

The contrast between the subregions of Middle America and the Caribbean is striking: in 1960 the proportion of arable to agricultural land in the Caribbean is more than twice that in Middle America. This is consistent with the equally higher population density in the Caribbean--ALF/ARABLE densities are 53.4 in the Caribbean and 25.9 in Middle America in 1960. (Densities are discussed in detail in Chapter V.) Within Middle America, a comparison between El Salvador and Honduras in 1960 is illustrative on this point:

	$\left(\frac{\text{ARABLE}}{\text{AGRI}}\right) \times 100$	$\left(\frac{\text{ALF}}{\text{ARABLE}}\right)$	$\left(\frac{\text{RURAL}}{\text{ARABLE}}\right)$
El Salvador	51.2	65.1	236.0
Honduras	26.3	32.6	152.5

The inverse relationship between the proportion of arable land and the population/agricultural density is consistent with the hypothesis that an increase in population pressure on arable land tends to reduce the proportion of pasture.

On the whole, arable land comprises less than 20 percent of all agricultural land in Tropical and Temperate South America in 1960. Except for Australia-New Zealand and South Africa, these regions have the highest proportions of pasture in the world.

Statistics on pasture are not available for the majority of Asian countries. According to those that are available, pasture comprises less than 10 percent of the agricultural land in 1960; the proportion is lowest in two countries of East Asia--Taiwan and South Korea.³⁶ The impact of high population densities on the proportion of pasture is thus well illustrated in the Asian countries included in our sample.

³⁶ Table 24 shows that 35.1 percent of the agricultural land in one country of East Asia--China--is arable. The data on pasture for 1950 are taken from F.A.O., Production Yearbook 1958. It was not possible to check the F.A.O. estimate of pasture against another statistical source.

POPULATION AND LAND IN WORLD AGRICULTURE

Interpretation of the European statistics on pasture requires a different perspective than merely the framework of population growth and food supply. The industrial revolution in Europe ended the dominance of the agricultural sector. Agriculture no longer served as the primary source of wealth; it now had to compete with other sectors of the economy. To understand how Western Europe is able to maintain about 40 percent pasture in view of its very high population density, it is necessary to review briefly the agricultural history of Europe.

According to Van Bath's authoritative account of European agricultural history,³⁷ economic depressions and booms were a major factor affecting agricultural production and the use of agricultural land for arable versus pastoral farming. However, this is probably only a part of the story. Prices and income levels in the agricultural and non-agricultural sectors were probably expressions of basic economic and demographic forces. Van Bath devotes a short chapter to the demographic history of Western Europe, but the lessons to be derived from it are not fully utilized in the later chapters.

The industrial revolution and the discovery of the Americas provided alternatives to hard-pressed farmers in Western Europe. This, plus a steady decline in death rates after the middle of the eighteenth century, was enough to encourage out-migration from rural areas. The constant rise in income levels in urban areas increased both the demand for food and for better quality food--particularly a larger share of animal products. But European farmers had to face tough competition from agricultural products from the Americas and the new colonies in Asia and Africa. In fact, for England, it was much more profitable to import cotton, jute, wheat, and other products (and export the finished products to the countries originally supplying these raw materials) than it was to devote arable land to such crops. Under these circumstances, pastoral farming became very profitable, and small farmers were squeezed out--a phenomenon known to historians as the "enclosure movement." Due to such pressures, new techniques for pasture evolved, and we find that 40-50 percent of the pasture in contemporary Europe is cultivated. In addition, methods of alternating between cereals and fodder crops in crop-rotation were perfected.³⁸

Van Bath gives several examples from European history of the transformation of arable land into pasture; Spain provides a particularly interesting case:

³⁷ B.H. Slicher Van Bath, The Agrarian History of Western Europe, A.D. 500-1850 (New York: St. Martin's Press, 1963; translated from Dutch by Olive Ordish).

³⁸ Ibid., pp. 246-250.

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After 1515 there was a growing discontent over the high cost of food and the farmers demanded a more helpful attitude from the government towards expansion of farmland. But Charles V (or I of Spain), who based his policy on the profits of the export trade in wool, set his face against any increase in cultivation and in 1525 decreed that all the land that had been turned into arable since 1517 must be restored to pasture for the use of sheep-grazers. The decree was repeated in 1540 to cover the period 1540-52. However, especially after 1535, as the import of American gold and silver increased, the price of grain began to rise rapidly. After 1550 the farmers' opposition to the Mesta grew fiercer; the king more and more granted permission for pasture to be turned over to arable crops. . . . The number of sheep under its control was highest in the years 1516-20, about 3 million, just after which it dwindled to barely two million. The cultivated area continued to expand until after 1609. Then, in the mid-seventeenth century, the drop in cereal prices repeated its unfavourable effect on arable farming. By the end of the century it had been displaced by sheep-grazing (in its sedentary form only) in nearly all Castile. This practically unregulated sheep-grazing proved fatal to arable farming.³⁹

The proportion of arable land in Eastern Europe (75.0 percent) is about 20 percentage points higher than that in Western Europe. Eastern Europe has been an important source of cereals for Western Europe during past centuries, but at present the importance given to arable farming in Eastern Europe seems to be due to a serious effort to become self-sufficient in food supply. Trade restrictions since World War II appear to have played an important role in arable versus pastoral farming in Eastern Europe. (Perhaps this is part of the answer to the question raised on p. 126 concerning the low proportion of fallow in Eastern Europe.)

Summary

The purpose of this chapter has been to study variations in the magnitude and composition of agricultural land throughout the world during 1950-60. Statistics on agricultural lands were collected from agricultural censuses and surveys and, in some cases, reliable estimates provided by F.A.O., etc. Agricultural land has been divided into arable land and pasture, and depending on the availability of data, arable land subclassified into cultivated land and fallow land, and pasture into cultivated pasture and natural pasture.

³⁹ Ibid., p. 168.

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Variations in the proportions of agricultural land and arable land to the total land area of a country were discussed. As in Chapter III, countries were grouped into four economic levels, five geographic regions, and 22 geographic subregions. Since geographic and environmental factors are crucial in determining the amount of agricultural land, little emphasis was put on the variations by economic levels. (The coefficients of variation of the proportion of arable land to total land, for example, are larger for the economic levels than for the main geographic regions.)

By adjusting for lack of data coverage in some regions, we estimated that the weighted proportion of arable land to the total area in the world increased from 9.62 percent in 1950 to 10.52 percent in 1960.⁴⁰ As for regional variations, in 1960 about 7 to 9 percent of the land was arable in Africa, the Middle East, and the Frontier Countries; the corresponding percentages for Asia and Europe were 19.25 and 31.28 respectively. More than one-third of the total land in Africa, Asia, and the Frontier Countries was devoted to agricultural production in 1960, compared to about one-half of the total land area in Europe, but only 10.2 percent in the Middle East.

We then attempted to explain the composition of the arable land by arguing that the proportion of fallow land to arable land is directly related to the cultivation system. The proportion of fallow would be highest under forest- and bush-fallow systems of cultivation, but much lower under short-fallow and annual cropping systems. The evidence presented in the chapter supports the thesis advanced by Boserup that land utilization is a dynamic phenomenon--i.e., under the pressure of increasing population, a community will tend to cultivate the land more extensively and intensively. Thus there would be a change from long-fallow systems to short-fallow and annual/multiple cropping systems. Therefore we hypothesized that the proportion of fallow to arable land is negatively associated with population density; on the whole, the evidence presented in the chapter supports this hypothesis. Extremely high densities (RURAL/ARABLE and TOT POP/ARABLE)--observed in Kenya and Lesotho in Africa, the U.A.R. in the Middle East, East Pakistan in South Central Asia, East Asia, Japan, Southeast Asia, and all of Europe except Southern Europe--are associated with extremely low proportions of fallow land. (In some cases there is no fallow land.) According to the very limited data at our disposal, about 50 percent or more of the arable land is cultivated more than once in high-density countries such

⁴⁰ As in the preceding chapter, in the phrase "weighted proportion" the weights are the denominator values in a proportion. In the present case, the weights are the total land area of countries.

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as China, Taiwan, East Pakistan, and the U.A.R. In India and West Pakistan, the corresponding percentage is around 15-20, and the level of RURAL/ARABLE density is less than one-half of that in the high-density countries. All this supports the hypothesis that, in the face of continuous increase in population and population density, the proportion of fallow land tends to decline, and the extent of multiple cropping increases. We estimated that the proportion of fallow land in the world declined from 23.82 percent of the arable land in 1950 to 22.02 percent in 1960.

Then the proportion of pasture to total agricultural land and the composition of pasture in terms of cultivated and natural pasture were discussed. The general theory regarding population growth and technological change in agriculture is equally applicable to pasture areas. The basic premise is that more agricultural land is required to supply food for a non-vegetarian population than for a vegetarian population of equal size. As long as industrial inputs play a minor role in an agricultural system, a society faced with continuous population growth will gradually convert pasture (particularly cultivated pasture) into arable land; this will be in addition to the more intensive use of existing arable land. Depending on the stage of evolution of land use and population growth, use of pasture will be affected by different kinds of pressures. During the early stages, in response to an increasing demand for livestock products, the proportion of cultivated pasture will be increased. However, since all natural pasture cannot be converted into cultivated pasture, an upper limit on the amount of cultivated pasture will be reached. If a population continues to grow at a high rate, it will become increasingly difficult to maintain the per capita consumption of meat products. Then, besides being used more intensively, arable land will be increased at the expense of cultivated pasture, decreasing the proportion of cultivated pasture to total pasture. This line of argument was summarized in two hypotheses:

- (1) The proportion of pasture to agricultural land will be lower in the countries with higher population densities;
- (2) The proportion of cultivated pasture will have a uni-modal relationship to population density; the proportion will rise with the density until it reaches a modal density, and then decline with increase in population density.

It was observed that the data coverage is poorer for pasture than for arable land, partly because pasture is an unimportant part of agricultural land in several countries--particularly in Asia. Less than 10 percent of the agricultural land in Asia was pasture in 1960, about 75 percent in Africa and the Frontier Countries, and about 40 percent in Europe. At a very general level, these proportions of pasture are negatively

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related to population densities, and therefore support hypothesis (1) above. Similar support can be found at the subregional level.

Finally, we determined that it is difficult to conclude anything about cultivated pasture because of the very poor data coverage, but some comparison between Europe and the Frontier Countries was possible. Excluding Southern Europe, about 40-50 percent of the pasture in Europe was cultivated in 1960; in the Frontier Countries, by contrast, the proportions in Temperate South America and Northern America were as low as 6.6 and 12.1 percent respectively. Such variations lend support to hypothesis (2) above--that the extent of cultivated pasture is dependent on the population density. However, it seems that the level of cultivated pasture in Europe is less than the modal value proposed in the hypothesis. (The European case is interesting because the responses to increasing demand of food are extreme in all respects: the proportion of arable land to agricultural land is very high, fallow land is almost negligible, and there is a very high level of cultivated pasture. In the future, if the productivity of Europe's arable land cannot be increased, and if importing cereals becomes difficult for economic reasons, the arable land in Europe may be increased at the expense of cultivated pasture.)

Chapter V

AGRICULTURAL DENSITY: THE RATIO OF AGRICULTURAL POPULATION TO AGRICULTURAL LAND

The relationship between the size of the agricultural population and agricultural land--i.e., agricultural density--is our main concern in this chapter. We shall study how average levels of agricultural density vary according to stages of economic growth and geographic locations. In the case of agricultural population, we found that economic level is more important in determining the size and growth of agricultural population than is regional location. On the other hand, in the case of agricultural land, we found that geographic and environmental conditions (regional location) are more important than economic level in determining the size and growth of agricultural land in a country. What are the key factors in determining agricultural density? Our discussion in this chapter will attempt to answer this question.

Further, we shall try to determine the patterns of change in agricultural density during 1950-60 according to economic levels and regional locations of countries. What are the relative contributions of changes in agricultural population and agricultural land to changes in agricultural density? Do these relative contributions depend on economic level and/or geographic location? In a case of drastic change (increase or decrease) in agricultural density, is change in agricultural population or change in agricultural land usually more important?

A second important purpose of this chapter is to examine some of the social and economic implications of different agricultural densities.¹ For instance, what are the effects of agricultural densities on farm size, land tenure, land reform policies, productivity of land and agricultural labor, proportion of land owners to laborers, etc.? Such questions are explored by Dovring in his previously cited study of European agriculture.²

¹One of these implications was explored at some length in Chapter IV--i.e., the effects of agricultural densities on patterns of land use in different regions and countries (see pp. 114-127).

²Land and Labor in Europe . . ., Chapters 3, 4, and 6. See also Kenneth L. Bachman and Raymond P. Christensen, "The Economics of

Most of them cannot be answered in general terms; they need to be examined in relation to the peculiar social and political structures and economic and agricultural development problems of individual countries. Detailed case studies are beyond the scope of this work, but we shall discuss a few cases briefly.

One important demographic implication of agricultural density is its effect on out-migration of agricultural population. Some economists have argued that high densities in agriculture create unemployment and underemployment among the agricultural population.³ (This is sometimes referred to as agricultural labor with a marginal productivity of zero, or "disguised unemployment in agriculture.") Consequently, high densities would cause migration to the nonagricultural sector. (This aspect of density will be examined in the next chapter.)

General Notes on Presentation of Data

We have seen that agricultural population data can be classified according to total population, rural population, agricultural labor force, or farm population. Similarly, agricultural land can be categorized as arable land, arable land plus cultivated pasture (i.e., arable land in a broader sense), or arable land plus pasture (i.e., total agricultural land). Each combination of a population group and a category of agricultural land constitutes a measure of agricultural density, which means there are twelve possible density measures. Obviously we must limit our discussion to two or three such measures.

In addition to selecting particular measures of agricultural density for consideration, we must decide what mode of weighting to use to obtain a weighted average for a group of countries. We noted in Chapter III (pp. 47-49) that two kinds of weighted averages can be computed: one by weighting with the numerator values of ratios, and the other by weighting with the

Farm Size" in Herman M. Southworth and Bruce F. Johnston, eds., Agricultural Development and Economic Growth (Ithaca: Cornell University Press, 1967), Chapter 7.

³ See Gunnar Myrdal, Asian Drama (New York: Random House, 1968), Chapter 21 ["Unemployment and Underemployment"], Appendix 6 ["A Critical Appraisal of the Concept and Theory of Underemployment"], and Appendix 16 ["A Critical Appraisal of Selected Studies on 'Unemployment' and 'Underemployment'"]. See also Theodore W. Schultz, Transforming Traditional Agriculture (New Haven: Yale University Press, 1964), Chapter 1.

denominator values.⁴ We pointed out that the two weighted averages are likely to be significantly different if the numerator and denominator of a ratio represent different types of characteristics. A density measure is such a case--the numerator representing population characteristics and the denominator land characteristics. Therefore, in our tables we shall show both kinds of weighted averages for each selected measure of agricultural density. Adding other information such as standard deviations, sums of weights, and numbers of countries for each weighted average would make the tables very lengthy and perhaps confusing. Therefore we must be selective in presenting our summary results.

Our aim at this point is to provide comparative ratios of agricultural population to agricultural land for various economic levels and geographic regions. In choosing the most appropriate measures, we should consider the coverage, quality, and comparability of the variables relating to agricultural population and agricultural land.

As a measure of agricultural population, the farm population--the agricultural labor force and its dependents--would seem to be most appropriate. However, our discussion in Chapter III (pp. 68-81) showed that data on farm population not only lack comparability (the source may be either a population census or an agricultural census), but also do not provide good coverage for Africa, Asia, and the Middle East, as well as for economic levels 1 and 2. Insufficient coverage is a serious enough drawback to rule out farm population as a useful measure. Rural population, by contrast, is an ideal measure with respect to coverage, but the strong possibility of an underestimated rural population in some countries of economic level 3 and in the Latin American and Southern European regions was established in Chapter III (pp. 83-88). In addition, variations of farm population within the rural population (FARM/RURAL) limit the comparability of density measures. However, FARM/RURAL ratio variations can easily be incorporated in our discussion. The excellent coverage and the conceptual association between farm and rural population, therefore, make the "rural population" an attractive proxy for the agricultural population.

The male agricultural labor force (ALF) is a very good measure of agricultural population from the standpoint of comparability and theoretical significance, but its coverage is poorer than that for the rural population (though better than for the farm population). The lack of coverage is especially serious in economic level 1 and in Africa. Nevertheless, on the whole, ALF is a reasonably good measure of agricultural population to use in agricultural density calculations.

⁴The computational formulae are shown in Chapter III, pp. 47-49.

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As a measure of agricultural land, arable land seems to be the best choice. The coverage of data on arable land is quite good in all regions, and arable land measures are generally comparable between countries (excluding such factors as land productivity and intensity of land use). However, the use of arable land as a base may produce an erroneous impression of high agricultural densities in regions where pastoral activities are important. As we noted in the preceding chapter, the coverage of pasture data is quite poor in Africa, the Middle East, and Asia, and pasture data are not as comparable as arable land data (pp. 134-139). In addition, differences in the productivity of arable land and pasture create problems when total agricultural land (arable + pasture) is used. For these reasons, we shall use arable land as the basic land measure in computing agricultural densities. We shall show the significance of pasture in the American and European regions, though, by adding cultivated pasture to arable land. For lack of a better term we shall call this sum of cultivated pasture and arable land CULTIVATED LAND (not to be confused with cultivated crop land).

We have reached, then, the conclusion that, for our purposes, RURAL/ARABLE and ALF/ARABLE are the best available measures of agricultural density. Where cultivated pasture can be included in arable land, obtaining CULTIVATED LAND, the utility of these measures can be enhanced. The usefulness of the ALF/ARABLE ratio as a measure of agricultural density has been effectively demonstrated by Kingsley Davis (who calls it farmer-farmland density)⁵ and by Dovring.⁶

In the tables of this chapter we show two kinds of weighted averages for the agricultural densities in a group of countries. For the weighted averages based on the numerator (population characteristic) values as weights, we use the expression population RURAL/ARABLE density. For the weighted averages based on the denominator (land characteristic) values as weights, we use the expression land RURAL/ARABLE density.

In these tables we show the sums of weights and standard deviations for the population weighted averages only. The sums of weights for the land weighted averages can easily be deduced from the tables. In Chapter III (p. 48), we showed that the weighted average based on denominator weights (i.e., the land weighted averages in the case of density) equals:

⁵"Population and the Further Spread of Industrial Society," Proceedings of the American Philosophical Society, Vol. XCV, No. 1 (1951), pp. 10-13.

⁶Land and Labor in Europe . . ., Chapter 3.

$$\frac{\sum x_i}{\sum y_i}$$

Since the land weighted averages and the sum of numerator weights, x_i , are shown in the tables, the sum of denominator weights, y_i , is easily calculated.

In general the coefficients of variation (standard deviation/mean) for the population weighted averages are about the same order of magnitude as those for the land weighted averages. The standard deviations for the land weighted averages are not shown, therefore, although the coefficients of variation for both kinds of weighted averages are.

Agricultural Densities According to Economic Levels

Variations in Crude Densities

Crude densities (TOT POP/TOT AREA) provide a good starting point for our analysis of agricultural densities. As the term implies, crude density is a crude measure of the concentration of the total population on the total land area.

In 1960 the population crude densities are more than 84 persons per km² in economic levels 1, 2, and 4. The average density among the countries in economic level 3 is about one-half of that in the other three groups. However, the land crude densities (i.e., densities weighted by denominator values) are about the same in economic levels 1, 3, and 4, which are about one-third the density in economic level 2 (41.65). Why do these two ways of weighting densities produce such different results? To understand this, we must elaborate on the underlying conceptual differences of the two kinds of weighted averages.

In Table 25 the population crude density and the land crude density in economic level 1 in 1960 are 86.27 and 17.50 respectively. By definition, these figures are obtained by weighting the crude densities of the countries in economic level 1 by total population and total area respectively. In an abstract sense, this means that a person selected at random from the 49 countries in economic level 1 (i.e., from 377,064,000 persons--see column (3), Table 25) would find himself among 86 persons on a square kilometer of land. On the other hand, on a square kilometer of land selected at random from the total land area of these 49 countries, there would be only 17.5 persons. In other words, a significant proportion of the total population of the 49 countries is concentrated in a few densely populated countries. Among the countries in economic level 1, four--Indonesia, North Vietnam, South Vietnam, and East Pakistan--have population crude

Table 25

AGRICULTURAL DENSITIES ACCORDING TO ECONOMIC LEVELS AND GEOGRAPHICAL REGIONS:
1950 AND 1960^a

Economic Level or Region	TOT POP/TOT AREA		RURAL/ARABLE		ALF/ARABLE		ALF/AGRI	
	1950	1960	1950	1960	1950	1960	1950	1960
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Economic Level 1								
N	70.48	86.27	295.70	395.11	84.90	115.36	33.68	6.34
(D)	(13.79)	(17.50)	(189.05)	(235.16)	(53.59)	(62.06)	(28.00)	(2.28)
sd	89.65	106.20	177.79	198.40	48.03	32.63	19.27	3.69
w	297,165	377,064	113,600	276,485	15,647	32,906	6,681	1,548
n	49	49	16	30	4	10	3	5
Economic Level 2								
N	69.45	84.09	359.26	357.55	43.85	52.17	37.68	46.33
(D)	(34.06)	(41.65)	(238.47)	(250.21)	(39.55)	(42.80)	(36.92)	(37.39)
sd	36.61	44.70	162.43	161.60	20.13	27.18	2.55	23.45
w	1,183,000	1,446,510	926,040	1,150,723	84,736	120,617	64,715	101,044
n	50	50	30	38	18	30	9	19

^aDensities are weighted by numerator--N--and denominator--(D)--values of the ratios; sum of weights--w--is the sum of the numerator (i.e., population figures) values, expressed in 000's, of ratios for each country in a group.

Table 25 (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Economic Level 3									
N		36.86	42.42	134.77	130.57	36.11	32.69	7.82	14.12
(D)		(11.01)	(13.75)	(99.64)	(103.41)	(25.20)	(25.38)	(4.80)	(5.76)
sd		43.22	57.85	73.88	73.98	26.56	21.91	5.39	24.92
w		234,392	292,765	125,757	149,104	27,714	32,081	19,717	30,843
n		27	27	21	25	15	19	10	18
Economic Level 4									
N		91.05	95.21	229.29	194.95	50.94	27.00	44.34	21.24
(D)		(13.51)	(15.42)	(72.34)	(65.74)	(13.05)	(9.12)	(3.81)	(2.68)
sd		91.54	98.69	326.55	254.23	59.14	35.68	56.55	34.94
w		772,066	880,723	354,903	359,422	42,052	49,215	37,245	45,059
n		30	30	26	27	25	25	21	21
Africa									
N		16.05	23.72	119.95	166.30	28.43	13.75	22.03	3.88
(D)		(7.07)	(9.23)	(76.71)	(92.92)	(26.84)	(11.00)	(6.55)	(1.85)
sd		12.79	20.47	61.25	105.37	8.20	8.21	10.17	3.36
w		155,899	204,280	91,956	152,728	8,425	5,668	7,316	3,178
n		41	41	17	32	4	10	3	6
Middle East									
N		18.81	24.44	254.09	225.92	62.66	50.04	--	22.72
(D)		(7.73)	(9.95)	(121.23)	(119.67)	(31.24)	(26.51)	--	(16.38)
sd		21.66	26.34	232.14	224.63	53.93	48.76	--	8.68
w		113,143	145,663	45,654	80,462	9,709	17,095	--	11,758
n		22	22	9	13	6	11	--	8

Table 25 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Asia								
N	90.93	108.77	413.31	413.91	61.45	72.38	51.03	54.87
(D)	(63.12)	(76.42)	(318.34)	(345.56)	(47.73)	(59.21)	(41.73)	(49.02)
sd	60.28	70.50	200.37	165.46	41.35	36.56	35.15	27.13
w	1,310,131	1,586,180	954,415	1,256,798	90,803	138,635	71,658	95,721
n	33	33	15	23	18	17	4	8
Frontier Countries								
N	13.19	16.00	86.94	75.93	29.73	18.74	8.45	5.14
(D)	(7.12)	(8.80)	(54.12)	(51.11)	(9.82)	(8.89)	(2.31)	(2.35)
sd	20.14	22.53	91.23	63.21	33.64	14.33	14.80	5.16
w	515,237	636,836	251,286	268,031	28,885	46,425	26,731	45,447
n	35	35	29	28	24	25	20	23
Europe								
N	131.24	139.87	145.01	146.82	27.86	23.26	18.78	14.26
(D)	(80.78)	(87.35)	(123.28)	(119.55)	(25.09)	(21.01)	(15.62)	(12.27)
sd	70.97	75.64	67.80	82.18	9.46	7.77	7.48	5.11
w	392,213	424,104	176,990	177,715	32,327	26,996	22,653	22,390
n	25	25	23	24	20	21	16	18
All Regions								
N	73.21	83.56	305.60	315.24	48.12	53.09	34.82	34.09
(D)	(18.46)	(22.25)	(142.72)	(152.11)	(25.18)	(23.46)	(8.09)	(6.99)
sd	67.87	76.02	222.06	202.13	39.40	40.06	33.13	30.48
w	2,486,623	2,997,063	1,520,300	1,935,734	170,150	234,819	128,358	178,494
n	156	156	93	120	62	84	43	63

densities of 62.7, 101.4, 82.5, and 349.3 respectively (see Appendix Table VII). These countries combined account for 46.0 percent of the total population, but only 9.1 percent of the total land area, in the 49 countries in economic level 1 in 1960. Thus the population weighted densities emphasize the concentration of people, and the land weighted densities emphasize the distribution of land. The greater the difference between the two weighted densities, the higher the concentration of population in a few countries.

During 1950-60 the population crude density in the world as a whole increased from 73.21 to 83.56, or by 14.1 percent, and the land crude density from 18.46 to 22.25, or by 20.5 percent. This increase was a direct function of the growth of population. The total population of the world increased by 20.5 percent during the same period--exactly the percentage of increase in the land crude density. Since the expression of the land weighted density is of the type $\frac{x_i}{y_i}$, we find that in general the percent change in the land weighted density is close to the algebraic difference between the percent changes in the population (x_i) and in the land (y_i).⁷

⁷ However, as stated above, the population crude density (TOT POP/TOT AREA) in the world increased by 14.1 percent. Why should this density (weighted by the total population of each country) increase by 14.1 percent when the world's population increased by 20.5 percent, and the total land area of the world is fixed? The answer lies in the mode of weighting. Since each density is weighted by the total population of the country, the increase in weighted density becomes primarily the function of the rates of increase of the total population among the large countries (with respect to size of population). In other words, the experience of small countries will scarcely be reflected in the rate of change of density weighted by total population. If we designate countries with population of more than 40 million (1960) as large countries, the list of such countries, with their percent exponential annual rates of growth during 1950-60, is as follows: U.S. (1.8), Brazil (3.2), China (1.8), Japan (1.1), Indonesia (2.1), India (1.9), East Pakistan (1.9), West Pakistan (2.4), U.K. (0.4), France (0.9), West Germany (0.9), Italy (0.6), and U.S.S.R. (1.8). With the exception of Brazil, the rates are less than 1.0 percent for European countries, and about 2.0 percent for non-European countries. The total population of these 13 large countries in 1960 is 2,002,388(000)--about 67 percent of the total population among the 156 countries of the world. Because of this dominance, the growth rates in these large countries are very heavily reflected in the increase of 14.1 percent (approximately 1.41 percent per year) for the population crude density of the world. On the other hand, the formula for the land crude density ($\Sigma x_i / \Sigma y_i$) is

Variations in RURAL/ARABLE Densities

The population RURAL/ARABLE densities in 1960 vary widely between economic levels 1 and 2, on the one hand, and levels 3 and 4, on the other (column (5), Table 25). On the average there are more than 350 rural persons per km² of arable land in the countries of economic levels 1 and 2, while there are less than 200 in the countries of levels 3 and 4. Like all other characteristics considered in this study, RURAL/ARABLE densities vary widely within economic levels:⁸

<u>Economic Level</u>	<u>Coefficient of Variation for the Population RURAL/ARABLE Density</u>
1	0.5021
2	0.4520
3	0.5666
4	1.3089

The variations of RURAL/ARABLE densities within economic levels by individual countries can be seen in Appendix Table VII. Here we shall cite only some extreme examples. In economic level 1, there are extremely high densities in 1960 in a few countries in Southeast Asia (Indonesia and North and South Vietnam) and in South Central Asia (East Pakistan and Nepal).⁹ On the other hand,

independent of the distribution of population among the world's countries.

If the rates of population growth were the same in all countries, the weighted average of crude density of the world would be the same whether the weights were land areas or total population. In other words, the difference between the population and the land density in a given year is the function of the variation of the total population (i.e., the numerator characteristic in general) among the countries. [This point is elaborated upon in pp. 169-172.]

It can easily be seen that the difference between the land weighted (denominator) and the population weighted (numerator) densities is also dependent on the nature of the unit used in a sample. For instance, if the basic units were counties instead of countries, the difference would have been even greater, because the variation of the numerator characteristic (total population) among counties of the world is greater than among countries. In either case, the denominator weighted densities would be the same because they are the ratio of the total population of the world to the total land area of the world.

⁸For means and standard deviations, see column (5), Table 25.

⁹Data are not available for Haiti in 1960, but in 1950 its RURAL/ARABLE density of 735.1 is the highest among the countries of economic level 1.

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a few African countries in economic level 1 have densities of less than 75.0 in 1960.

In economic level 2, South Korea, with a population RURAL/ARABLE density of 953 in 1960, leads all the countries in the world. The next highest density is in the U.A.R. (662); French Guiana (543) and Ceylon (498) also have high agricultural densities. At the opposite end of the scale, the Republic of Congo and Sarawak (both in economic level 2) have extremely low densities--around 22 in 1960. China and India have RURAL/ARABLE densities in 1960 of 474 and 220 respectively.

Among the countries in economic level 3, Jamaica, Surinam, and Taiwan have very high RURAL/ARABLE densities in 1960 (more than 425). On the other hand, the densities in Argentina and Uruguay in 1960 are less than 45.

The coefficient of variation is highest for the highly developed countries in economic level 4, which can be divided into three categories according to their RURAL/ARABLE densities. The first category consists solely of Japan, which has a highly labor-intensive agricultural system and a density in 1960 of 794--the second highest density among all the countries in our sample. The second category is comprised mainly of European countries with an average density of around 150 rural persons per km² of arable land. The third category consists of countries of the so-called "New World" with highly mechanized agricultural systems, such as Canada, the U.S., and Australia, as well as South Africa and the U.S.S.R.; the RURAL/ARABLE densities range from 15 in Australia and Canada to 73 in South Africa.

In view of the great diversity of countries within economic levels, we should not expect a systematic trend of population RURAL/ARABLE densities between economic levels. However, as we noted earlier, there is a remarkable difference in densities between economic levels 1 and 2 and levels 3 and 4. The RURAL/ARABLE densities are influenced by the proportion of the farm population within the rural population (FARM/RURAL) and by FARM/ARABLE densities. Outmigration of the farm population and the mechanization of agriculture, which are most pronounced at the higher economic levels, tend to reduce FARM/ARABLE densities, as the following data appear to indicate:

<u>Economic Level</u>	<u>Number of Countries</u>	<u>FARM/ARABLE Density (Weighted by Farm Population)</u>
2	19	294.36
3	18	138.04
4	23	140.30

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Though a number of reasons have been given for the incomparability of farm populations between economic levels (see Chapter III), they are not adequate to account for the decline in FARM/ARABLE density of more than 50 percent between economic levels 1 and 2, on the one hand, and levels 3 and 4, on the other. For the sake of argument, we can assume that the FARM/ARABLE densities are not significantly different between economic levels 3 and 4. This is consistent with the relative magnitudes of the population ALF/ARABLE densities in 1960 according to economic levels (column (7), Table 25).

In Chapter III (Table 13) we found that the FARM/RURAL proportion in economic level 4 is significantly lower than that in economic level 3. Since the FARM/ARABLE densities in the two economic levels are similar (138.0 and 140.3), the lower proportion of FARM/RURAL population in economic level 4 would produce a higher level of RURAL/ARABLE density than for economic level 3, since: $\frac{\text{RURAL}}{\text{ARABLE}} = \frac{\text{FARM}}{\text{ARABLE}} \times \frac{1}{\text{FARM/RURAL}}$. Also in Chapter III, we concluded that--on the whole--the rural population in economic level 3 is underestimated because of the types of definitions used (pp. 83-88). The observed RURAL/ARABLE density (weighted by the rural population) in economic level 3 in 1960 is about 33 percent less than that in economic level 4 (column (5), Table 25). The underestimation of rural populations in economic level 3 cannot explain such a large difference in densities. The underestimation would not be on the order of 33 percent, but around 20 percent. Therefore, the low level of the RURAL/ARABLE density in economic level 3 (in comparison to level 4) must stem partly from its underestimated rural population and partly from its higher FARM/RURAL proportion.

Thus far we have discussed only population RURAL/ARABLE densities. Land RURAL/ARABLE densities--i.e., densities weighted by the denominator (arable land) values--are shown in Table 25 in parentheses. As in the case of population densities, land RURAL/ARABLE densities in 1960 are approximately the same (around 250) in economic levels 1 and 2, but decline appreciably in levels 3 and 4--from 103 in level 3 to 66 in level 4.

<u>Economic Level</u>	<u>Population RURAL/ARABLE Land RURAL/ARABLE</u>	<u>Coefficient of Variation for the Land Densities</u>
1	1.68	0.8247
2	1.43	0.6550
3	1.26	0.5124
4	2.96	1.4020

Population densities are always greater than land densities, but in economic level 4 the difference between the two is extreme. This is, of course, a function of the variation of

RURAL/ARABLE densities within economic level 4, discussed earlier in the chapter (pp. 154-155). More than four-fifths of the arable land in economic level 4 countries is in five countries with very low RURAL/ARABLE densities--Canada, the U.S., Australia, South Africa, and the U.S.S.R. The U.S. and the U.S.S.R. alone account for 69.2 percent of the total arable land in the 27 highly advanced countries in 1960, but only 44.9 percent of the rural population. The five countries together have 80.5 percent of the arable land and 49.5 percent of the rural population. The remaining 22 countries in economic level 4 (most of Europe and Japan), therefore, have only 20 percent of the arable land but 50 percent of the total rural population. Such wide differences between concentration of population and land area make the weighted averages for economic level 4 almost meaningless. (The variations in densities between countries will be examined in greater detail in the discussion of geographic subregions.)

The Trend of RURAL/ARABLE Densities during 1950-60

The trend of RURAL/ARABLE densities during 1950-60 cannot be determined from the data in Table 25. For this we must turn to Table 26, in which countries are matched for 1950 and 1960. In the process of matching, data on several countries--particularly in economic level 1--are lost. On the basis of the data, the only economic level in which an increase in population RURAL/ARABLE density occurred during 1950-60 was level 1, where there was a 15 percent rise. In economic levels 2 and 3, the density declined by less than 5 percent during 1950-60, while in economic level 4 it fell by almost 18 percent. Thus the pressure on arable land declined considerably during 1950-60 in the advanced countries, whereas there was a substantial increase in the pressure on arable land (or little change) in the less developed countries. This pattern has been one of the major factors contributing to the growing economic disparity between the advanced and less developed countries in recent years.

Changes in agricultural densities are a function of the differential between the growth of the rural population and the increase of arable land. From Table 26 we can compute the growth rates. This tabulation shows that the growth of the rural population is highest in countries of economic level 1, and declines progressively through levels 2, 3, and 4. In economic level 4 the rural population changed very little during 1950-60. But the trend is reversed when increases of arable land are considered, with the increase being highest in economic level 4. On the whole, rises in RURAL/ARABLE density derive mainly from increases in the rural population, while density declines are due mainly to increases in arable land, with little change in the rural population. The expansion of arable land during 1950-60 in economic level 2 was as much as in level 3 (about 8 percent), but the

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Table 26

AGRICULTURAL DENSITIES IN MATCHED COUNTRIES ACCORDING TO
ECONOMIC LEVELS AND GEOGRAPHICAL REGIONS: 1950 and 1960

Economic Level or Region	RURAL/ARABLE		ALF/ARABLE		ALF/AGRI	
	1950	1960	1950	1960	1950	1960
(1)	(2)	(3)	(4)	(5)	(6)	(7)

Economic Level 1

N	285.20	329.69	111.64	133.35	--	--
(D)	(186.03)	(228.84)	(111.64)	(133.35)	--	--
sd	165.86	188.21	0.00	0.00	--	--
w	110,733	140,685	8,966	10,867	--	--
n	13	13	1	1	--	--

Economic Level 2

N	361.07	356.62	43.96	50.97	37.70	44.84
(D)	(241.98)	(259.07)	(39.59)	(46.78)	(37.50)	(44.11)
sd	161.45	141.45	20.31	19.11	1.96	2.95
w	919,656	1,068,585	83,017	102,874	63,237	80,739
n	27	27	15	15	6	6

Economic Level 3

N	134.77	127.93	36.08	32.54	7.82	7.40
(D)	(99.64)	(100.42)	(24.98)	(25.03)	(4.80)	(4.85)
sd	73.88	76.15	26.93	22.49	5.39	4.36
w	125,757	136,237	26,968	29,217	19,717	22,445
n	21	21	14	14	10	10

Economic Level 4

N	229.29	188.60	51.74	37.98	45.24	33.35
(D)	(72.34)	(64.39)	(12.90)	(10.00)	(3.72)	(2.51)
sd	326.55	254.03	59.75	40.93	57.19	40.78
w	354,903	350,822	40,929	31,242	36,122	27,086
n	26	26	24	24	20	20

Africa

N	122.69	149.41	18.18	13.04	1.57	1.53
(D)	(77.74)	(93.03)	(18.18)	(13.04)	(1.57)	(1.53)
sd	61.22	70.70	0.00	0.00	0.00	0.00
w	87,972	112,892	1,393	1,573	1,393	1,573
n	16	16	1	1	1	1

Table 26 (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Middle East						
N	254.09	280.33	62.66	65.33	--	--
(D)	(121.23)	(134.49)	(31.24)	(33.46)	--	--
sd	232.14	254.04	53.93	56.04	--	--
w	45,654	54,730	9,709	10,674	--	--
n	9	9	6	6	--	--
Asia						
N	413.36	396.58	61.45	62.65	51.10	49.75
(D)	(318.50)	(334.80)	(47.73)	(54.85)	(41.68)	(47.28)
sd	200.34	151.63	41.35	29.49	35.36	15.56
w	954,268	1,095,425	90,803	109,603	70,790	85,982
n	13	13	8	8	3	3
Frontier Countries						
N	79.03	73.28	24.35	24.85	5.70	6.09
(D)	(53.24)	(50.20)	(9.22)	(9.27)	(2.20)	(1.97)
sd	60.80	61.55	17.90	14.01	5.53	5.45
w	246,166	261,446	26,770	26,831	25,363	25,599
n	26	26	20	20	17	17
Europe						
N	145.01	147.07	28.07	22.70	18.95	14.18
(D)	(123.28)	(118.97)	(25.23)	(20.61)	(15.62)	(12.01)
sd	67.80	83.57	9.56	7.37	7.66	4.99
w	176,990	171,836	31,204	25,519	21,530	16,755
n	23	23	19	19	15	15
All Regions						
N	305.73	301.28	48.42	50.69	35.04	35.98
(D)	(143.04)	(146.94)	(24.87)	(26.51)	(7.68)	(7.53)
sd	221.54	190.76	38.90	33.34	34.01	23.38
w	1,511,049	1,696,330	159,879	174,200	119,076	129,909
n	87	87	54	54	36	36

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Percent Change during 1950-60 in:

Economic Level	n ^a	Rural ^b Population ^c	Arable ^b Land ^d	Land RURAL/ARABLE Density	Population RURAL/ARABLE Density
1	13	27.0	3.4	23.0	15.6
2	27	16.2	8.5	7.1	-1.2
3	21	8.3	7.5	0.8	-5.1
4	26	-1.1	11.1	-11.0	-17.8

^aNumber of countries.

^bThe formula for computation is $(\frac{\Sigma P_{60}}{\Sigma P_{50}} - 1)$, which means that the percent change in each country in a group is weighted by the rural population/arable land ratio in 1950. (See notes for Table 17, Chapter III.)

^cObtained by using the sum of weights, w--that is, the sum of the rural populations shown in columns (2) and (3) in Table 26.

^dAlthough the absolute figures for arable land are not shown, they can be computed as $= (\frac{w}{\text{Land RURAL/ARABLE Density}})$. See p. 148.

growth of rural population in level 2--almost twice that in level 3--negated the effects of more arable land.

The different percent changes in the population RURAL/ARABLE densities and the land RURAL/ARABLE densities show that changes in rural population vis-à-vis arable land are not uniform within economic levels. The method of computation of the population and land weighted averages (numerator and denominator weights respectively--see footnote 4, Chapter III) indicates that the percent change in the land RURAL/ARABLE density is approximately the algebraic difference of the percent changes in the rural population and arable land. This is not necessarily the case for the population RURAL/ARABLE density (see footnote 7, this chapter).

Variations in ALF/ARABLE Densities

Earlier in this chapter (p. 147) it was pointed out that the ALF/ARABLE ratio, which denotes the number of male agricultural workers per unit of arable land, is a very good measure for comparing agricultural densities. Unlike the rural

population (RURAL), the agricultural labor force (ALF) is quite comparable among countries (pp. 82-83, Chapter III).

In Chapter III (pp. 82-86), we showed that the RURAL/ALF ratio tends to increase with rises in the economic level, particularly at the higher economic levels. Therefore, although the trends and variations of the ALF/ARABLE densities can be expected to follow the patterns of the RURAL/ARABLE densities, the declines in the ALF/ARABLE densities at the higher economic levels will be greater than in the RURAL/ARABLE densities. This is clearly shown in Table 25. For instance, in 1960 the population ALF/ARABLE density for economic level 4 is 23.4 percent of the density for economic level 1, while the corresponding proportion for the RURAL/ARABLE density is 49.3 percent. Despite such differences, a detailed discussion of ALF/ARABLE densities according to economic levels would largely overlap the preceding discussion of RURAL/ARABLE densities; therefore, we shall not cite levels of ALF/ARABLE densities for specific countries within economic levels, but shall deal only with overall levels.

In Table 25 (column 7) we find that both the population and the land ALF/ARABLE densities in 1960 decline consistently as we move from economic level 1 to level 4. Even though the weighted averages for the small number of countries in economic level 1 are probably overestimated, there is clearly a decline in densities. If we disregard economic level 1, we can still perceive a definite decline of the weighted ALF/ARABLE densities in the other three economic levels. The population ALF/ARABLE density in economic level 4 (27.00) is about one-half of that in economic level 2, and the land ALF/ARABLE density (9.12) about one-fifth.¹⁰ These are among the most important findings of this study.

The differences in agricultural densities between economic levels 2 and 4 would be even greater if we included pasture in the

¹⁰ Table 25 shows that in economic level 4 the population ALF/ARABLE densities are 50.94 and 27.00 in 1950 and 1960 respectively. Although there are 25 countries in both years, they are not necessarily the same 25 countries at the two different dates. In Table 26 the matching of countries resulted in population ALF/ARABLE densities of 51.74 and 37.98 in 1950 and 1960, based on 24 countries. One large country had the relevant data for 1960, but not for 1950--the U.S.S.R. The effect of the U.S.S.R. on the weighted average is very substantial: the exclusion of its data increases the population ALF/ARABLE density from 27.00 to 37.98 in 1960. In 1960 the U.S.S.R. contained 36.5 percent of the ALF and 42.1 percent of the arable land among the 25 countries of economic level 4.

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land measurement. This is because arable land is the larger part of agricultural land in economic level 2, but not in levels 3 and 4 (Table 20, Chapter IV). As noted earlier in the chapter (p. 148), we can take into account the importance of pasture in certain regions by adding cultivated pasture to arable land, obtaining CULTIVATED LAND (or arable land in an extended sense). However, as shown in Chapter IV (Table 20), the coverage of data concerning cultivated pasture is quite poor. Therefore, if we simply relied on the available data, the number of countries for which it would be possible to compute the ALF/CULTIVATED ratio would be very few, and the results possibly misleading.

We can use an indirect method to compute ALF/CULTIVATED densities, by assuming that the proportions ARABLE/AGRI and CULT PAST/PAST for the "non-sample" countries (i.e., those which do not have data on cultivated land) are the same as those for the "sample" countries. In this way, by using the weighted averages of ALF/ARABLE densities, we can obtain estimates of ALF/CULTIVATED densities for more countries than those having data on cultivated pasture. Under these assumptions we obtain the following identity:¹¹

$$\frac{\text{ALF}}{\text{CULTIVATED}} = \frac{\text{ALF}}{\text{ARABLE}} \times \frac{1}{1 + \frac{\text{CULT PAST}}{\text{PAST}} \left[\frac{\text{AGRI}}{\text{ARABLE}} - 1 \right]}$$

The important results are set forth in Table 27. The weighted ALF/CULTIVATED densities are substantially lower than the corresponding ALF/ARABLE densities in economic level 3--about 35.0 percent less. The densities are about 20.0 percent lower for economic level 4, but only about 3.5 percent less for level 2. In my opinion the ALF/CULTIVATED densities provide a much better comparison of agricultural densities by economic levels than do the ALF/ARABLE densities. The figures in column (6) of Table 27 indicate that a typical male agricultural worker in a country of economic level 2 has more than twice as many co-workers on a unit of cultivated land as his counterpart in a country of economic level 3 or 4. Column (7) shows that a typical unit of land in economic level 2 is cultivated by about twice the number of workers as in level 3, and 5-1/2 times the number of workers as in level 4. The population ALF/CULTIVATED density in economic level 4 is almost three times that of the land ALF/CULTIVATED density. This difference is the same order of magnitude as that found in the RURAL/ARABLE densities.

¹¹ The identity can be verified by substituting AGRI = ARABLE + PAST and CULTIVATED = ARABLE + CULT PAST.

Table 27

AGRICULTURAL DENSITIES BY ECONOMIC LEVELS: 1960

Eco- nomic Level	Population ALF/ARABLE Density	Land ALF/ ARABLE Density	<u>CULT PAST</u> PAST	<u>ARABLE</u> AGRI	Population ALF/ CULTIVATED Density	Land ALF/ CULTIVATED Density
(1)	(2)	(3)	(4)	(5)	(6)	(7)
2	52.17	42.80	0.2098	0.8571	50.41	41.35
3	32.69	25.38	0.1036	0.2284	24.21	18.80
4	27.00	9.12	0.0819	0.2903	22.50	7.60

Sources: Columns (2) and (3): Table 25, column (7); column (4): Chapter IV, Table 20, column (5); column (5): Chapter IV, Table 20, column (3); and columns (6) and (7): computed by using the identity shown on p. 162.

The Trend of ALF/ARABLE Densities during 1950-60

The trend of ALF/ARABLE densities during 1950-60 is shown in Table 26. The sole country representing economic level 1 is East Pakistan. For economic levels 2, 3, and 4, a table similar to the one for RURAL/ARABLE densities (p. 160) can be computed:

<u>Percent Change during 1950-60 in:</u>						
Economic Level	n	ALF	ARABLE	Land ALF/ARABLE Density	Population ALF/ARABLE Density	
2	15	23.9	4.9	18.2	15.9	
3	14	8.3	8.1	0.2	-9.8	
4	24	-23.7	-1.6	-22.5	-26.6	

Note: See the notes for the table on p. 160.

Since the computations for weighted averages of ALF/ARABLE densities are based on fewer countries than are those for RURAL/ARABLE densities, the results set forth in the two tables are not precisely comparable. In particular, the increase in arable land by economic levels is appreciably different for economic levels 2 and 4--especially level 4.¹²

¹²The 26 countries for which the RURAL/ARABLE density was calculated had an 11 percent increase in arable land during 1950-60,

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On the basis of the available data for economic levels 2, 3, and 4, the level 4 countries (excluding the U.S.S.R.) show the highest declines in ALF/ARABLE densities during 1950-60 among the three economic levels. These declines (22.5 and 26.6 percent) are almost entirely due to a decline in the agricultural labor force. For economic level 2, there are increases in both the population and the land ALF/ARABLE densities during 1950-60--due primarily to an increase in the ALF. In contrast to economic levels 2 and 4, in economic level 3 the ALF and arable land increased by the same amount (8.0 percent), causing no change in the land ALF/ARABLE density. But the population ALF/ARABLE density in level 3 declined by 9.8 percent, suggesting that the ALF decline was confined mainly to a few large countries. An examination of Appendix Table VII shows that the data for Brazil alone largely explain the differences between the trends of the population and the land ALF/ARABLE densities in economic level 3 during 1950-60. During the decade the population ALF/ARABLE density in Brazil declined from 43.50 to 33.25, or by 23.6 percent. The Brazilian agricultural labor force in 1960 is 30.5 percent of the total ALF among the 24 countries in level 3; such a high percentage significantly affects the weighted averages using ALF as weights.

Agricultural Densities According to Geographic Regions

Since the main geographic regions are as heterogeneous as the economic levels, an extensive discussion of the variation of agricultural densities by regions would largely repeat the preceding discussion on economic levels. Therefore we shall deal only briefly with the weighted agricultural densities of the regions, leaving such material for a subsequent discussion of geographic subregions.

while the 24 countries for which the ALF/ARABLE density was calculated had a 1.6 percent decline in arable land. In other words, the two countries that did not have data on ALF/ARABLE densities in 1960 were wholly responsible for the 11 percent increase in arable land shown in the RURAL/ARABLE density table. From Appendix Table VII we can see that the U.S.S.R. and Czechoslovakia are the two countries involved. Czechoslovakia registered no change in arable land, but in the U.S.S.R. arable land increased from 1.68 million km² in 1950 to 2.27 million km² in 1960, or by 35.1 percent. The increase in arable land in the U.S.S.R. is 591,150 km², as compared to a total increase of arable land of 542,000 km² among the 26 countries. The exclusion of the U.S.S.R., therefore, explains the 1.6 percent decline in arable land noted above in economic level 4.

AGRICULTURAL DENSITY: AGRICULTURAL POPULATION/AGRICULTURAL LAND

In Table 25 it can be seen that Asia has the highest agricultural density among the five geographic regions. In 1960 the population RURAL/ARABLE density in Asia is 413.9, as compared to the next highest density of 225.9 in the Middle East. Although the agricultural systems in Africa and Europe are different in many ways, their population RURAL/ARABLE densities are remarkably similar (about 150). The peculiar composition of the Frontier Countries results in their having the lowest agricultural density.

In 1960 the population ALF/ARABLE density in Asia is four times higher than that in the Frontier Countries, and slightly more than three times higher than the level in Europe. When we consider the land ALF/ARABLE densities, the differences between the regions are even more salient. The agricultural density in Asia is more than six times the density in the Frontier Countries, and almost three times the European density. (The figure for the Frontier Countries, of course, reflects the concentration of arable land in a few countries with very low ALF/ARABLE densities.)

Following the method used for the economic levels (pp. 162-163), we can determine the effects of variations in cultivated pasture on agricultural densities according to geographic regions. The net effect on agricultural densities of adding cultivated pasture to arable land is the same in the Frontier Countries and Europe (Table 28). In both regions the weighted ALF/ARABLE densities are reduced by about 24.0 percent. Because of the lack of data for Asia and the Middle East, we were unable to compute the ALF/CULTIVATED densities in these regions, but the reduction in the ALF/ARABLE density in Asia is not likely to have been significant.

Table 28

AGRICULTURAL DENSITIES IN EUROPE AND THE FRONTIER COUNTRIES:
1960

Region	Popula- tion ALF/ ARABLE Density	Land ALF/ ARABLE Density	<u>CULT PAST</u> PAST	<u>ARABLE</u> AGRI	Population ALF/ CULTIVATED Density	Land ALF/ CULTIVATED Density
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Frontier Coun- tries	18.74	8.89	.0843	.2514	14.98	7.11
Europe	23.26	21.01	.3501	.6041	18.92	17.09

Sources: Same as in Table 27.

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The Trend of RURAL/ARABLE Densities during 1950-60

We can analyze the trend of RURAL/ARABLE densities by geographic regions in a manner similar to that employed for economic levels (p. 160). The following results are derived from Table 26:

<u>Percent Change during 1950-60 in:</u>					
Region	n	Rural Population	Arable Land	Land RURAL/ ARABLE	Population RURAL/ ARABLE
Africa	16	28.3	7.2	19.7	21.8
Middle East	9	19.9	8.0	10.9	10.3
Asia	13	14.8	9.2	5.1	-4.1
Frontier Countries	26	6.2	12.6	-5.7	-7.3
Europe	23	-2.9	0.6	-3.5	1.4

Note: See the notes for the table on p. 160.

It is clear from the figures for the number of countries (n) in Table 26 (columns 2 and 3) that the countries in Africa, the Middle East, and Asia are inadequately represented--more than half of the countries in these regions are not used in computing the trend from 1950 to 1960. This means that the results from these regions probably have limited comparability with those from Europe and the Frontier Countries, where coverage is better. Despite this limitation, there are some interesting patterns in the trends of the weighted RURAL/ARABLE densities. During 1950-60 the growth of arable land has been almost the same--around 8 percent--in Africa, the Middle East, and Asia, while exceeding 12 percent in the Frontier Countries. By contrast, there has been virtually no change in the amount of arable land in Europe during 1950-60. Thus changes in arable land have played an important role in the trends of RURAL/ARABLE densities in all regions except Europe. Further differences among the trends in Africa, the Middle East, Asia, and the Frontier Countries have been due to differential growth of the rural populations. Whether the population RURAL/ARABLE density or the land density is considered, Africa shows the highest increase in agricultural density during 1950-60 (about 20 percent) because the rate of growth of the rural population--more than 28.0 percent during 1950-60--is substantially higher in Africa than anywhere else.

In Asia, even though the average growth of the rural population is higher than that of arable land, the population RURAL/ARABLE density has declined by 4.1 percent. On the other hand--as expected--the land RURAL/ARABLE density has risen by 5.1 percent. (As a general rule, the percent change in the land

AGRICULTURAL DENSITY: AGRICULTURAL POPULATION/AGRICULTURAL LAND

density roughly equals the algebraic difference of percent changes in the numerator and the denominator characteristics.) This indicates considerable variation in the trends of RURAL/ARABLE densities in Asia, well illustrated by a comparison of the trends in China and India.

Percent Change during 1950-60 in:

	<u>Rural Population</u>	<u>Arable Land</u>	<u>RURAL/ ARABLE</u>
China	13.2	17.5	-4.5
India	20.6	3.4	16.7

The total increase in arable land among the 13 countries in Asia for which the RURAL/ARABLE densities are computed in 1950 and 1960 is 276,000 km², of which China alone contributed 175,530 km²--or 63.6 percent of the total increase. Besides China, an important contributor to the decline in the population RURAL/ARABLE density of Asia is Japan, where the density fell from an extremely high level of 998.1 in 1950 to 794.2 in 1960, or by 20.4 percent.

Since China and India contain most of the rural population and arable land among the 13 Asian countries used in Table 26, their levels and trends of RURAL/ARABLE densities dominate the calculations for Asia. It is important that we determine the Asian densities exclusive of China and India, as follows:

<u>Region</u>	<u>n</u>	<u>Land RURAL/ARABLE Density</u>		<u>Population RURAL/ARABLE Density</u>	
		<u>1950</u>	<u>1960</u>	<u>1950</u>	<u>1960</u>
Asia, excluding China	12	228.89	256.23	322.45	315.64
Asia, excluding China and India	11	374.71	378.55	563.87	501.36
Asia, including China and India	13	318.50	334.58	413.36	396.58

The population RURAL/ARABLE densities of China in 1950 and 1960 are 496.54 and 474.21 respectively, with the corresponding Indian densities being 188.12 and 219.57. Thus the Chinese densities are much closer to the population RURAL/ARABLE densities for the rest of Asia (excluding China and India) than are the Indian densities.

When India is excluded, both land and population RURAL/ARABLE densities rise sharply. For instance, the population

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RURAL/ARABLE density of Asia (excluding China) for 1960 increases by 58.8 percent (from 315.64 to 501.36) when India is removed. The extremely high densities of Asia excluding China and India reflect the high levels of two particular countries--Japan and East Pakistan. In 1960 Japan and East Pakistan account for about 52 percent of the rural population in the 11 remaining Asian countries. Their population RURAL/ARABLE densities are 794.17 and 580.67 respectively.

The average RURAL/ARABLE densities in Asia (less China and India) are higher than in any other region of the world. These densities are such that, on the average, in rural areas in Asia (excluding China and India) 501 persons are dependent on each square kilometer of arable land. The same holds true for an average rural area in China. The great miseries stemming from the overcrowding of Asian rural areas are compounded by a lack of economic development in the urban areas. Japan is, of course, an exception to this general situation. Due primarily to rapid industrialization in Japan during the post-World War II period, the rural areas of Japan experienced some measure of relief. The population RURAL/ARABLE density declined from 998.1 to 794.2 during 1950-60 because of an 8 percent decline in rural population and a 16 percent increase in arable land. Such a substantial increase in arable land reflects, most likely, a postwar restoration of Japanese agriculture.

The Trend of ALF/ARABLE Densities during 1950-60

The trends of ALF/ARABLE densities by geographic regions during 1950-60 are illustrated by the following:

<u>Percent Change during 1950-60 in:</u>					
<u>Region</u>	<u>n</u>	<u>ALF</u>	<u>Arable Land</u>	<u>Land ALF/ARABLE Density</u>	<u>Population ALF/ARABLE Density</u>
Middle East	6	9.9	2.6	7.1	4.3
Asia	8	20.7	5.0	14.9	1.9
Frontier Countries	20	0.2	-0.3	0.5	2.0
Europe	19	-18.2	0.1	-18.3	-19.1

Note: See the notes for the table on p. 160.

The coverage of data here is poorer than for the RURAL/ARABLE densities. Africa is missing altogether; and the Middle East and Asia are represented by only 6 and 8 countries respectively. China is not included in Asia, and the U.S.S.R. is not included

in the Frontier Countries.¹³ Because of these omissions, the percent changes in arable land according to regions are not comparable with those shown in connection with RURAL/ARABLE density (p. 166), and because the coverage is poor, no significant conclusions can be drawn concerning Africa, the Middle East, or Asia.

On the whole there is little change in ALF and arable land in the Frontier Countries, but as we have seen in earlier chapters, there are probably significant variations within the region. The drastic decline of the population and the land ALF/ARABLE densities in Europe--about 19 percent--is attributable to the decline in the agricultural labor force.

Variations in RURAL/ARABLE Densities According to Geographic Subregions

The population--N--and the land--(D)--RURAL/ARABLE densities for geographic subregions are shown in Table 29, columns (8)-(13). The weighted averages for 1950 and 1960 are computed according to the availability of data for the respective dates, and therefore are not necessarily comparable for the two dates.

The population RURAL/ARABLE density for 1960 for "All Regions" is shown in Table 25 as 315.2. Thus we shall designate as "high density" those subregions which have a population density higher than 315.2. On this scale, North Africa, East Asia, Japan, and Southeast Asia are high density subregions. When the emphasis is on the population concentration on arable land, we shall call "high density" those subregions in which the land RURAL/ARABLE density is higher than 152.6--the weighted average for "All Regions" in Table 25. In this case, East Africa, the Caribbean, East Asia, Japan, Southeast Asia, South Central Asia, and Oceania qualify as "high density" subregions (Table 29, column 13). Thus with either weighting, East Asia, Japan, and Southeast Asia are among the high agricultural density regions of the world.

As has been pointed out earlier in this chapter, the difference between the population and the land densities is a function of the variation of RURAL/ARABLE density within regions. In Chapter III (p. 47), we showed that the weighted averages of n densities (x_i/y_i) are:

$$\text{Population Density} = \frac{1}{\sum x_i} \sum \frac{x_i^2}{y_i}$$

¹³The changes in arable land have been described in footnote 12 of this chapter.

Table 29

AGRICULTURAL DENSITIES ACCORDING TO GEOGRAPHIC SUBREGIONS: 1950 AND 1960

(Densities are weighted by numerator--N--and denominator--(D)--values of the ratios.)

Subregion	TOT POP/TOT AREA						RURAL/ARABLE					
	1950			1960			1950			1960		
	n (2)	N (3)	(D) (4)	n (5)	N (6)	(D) (7)	n (8)	N (9)	(D) (10)	n (11)	N (12)	(D) (13)
(1)												
Northern Africa	7	14.8	6.1	7	18.6	7.8	3	383.7	154.6	5	352.6	142.9
Western Africa	15	24.0	9.1	15	36.2	13.3	6	115.3	104.2	13	152.7	100.3
Eastern Africa	13	14.3	9.0	13	19.7	11.5	6	164.6	147.6	9	211.1	175.4
Middle and Southern Africa	12	5.1	3.2	12	6.2	3.8	4	40.8	27.6	9	110.5	34.8
South Africa (Republic)	1	10.2	10.2	1	13.1	13.1	1	99.0	99.0	1	73.2	73.2
Northern America	3	15.0	7.7	3	17.7	9.2	2	31.7	30.2	2	34.2	32.0
Middle America	8	17.8	13.9	8	24.0	18.8	8	97.5	87.1	7	93.8	82.4
Caribbean	7	99.5	66.0	7	114.9	82.4	6	392.7	244.3	6	272.4	208.4
Tropical South America	9	6.6	6.1	9	9.1	8.3	6	159.9	151.0	6	143.2	140.9
Temperate South America	5	6.9	6.5	5	8.3	7.8	4	60.6	37.4	4	62.6	45.1
East Asia	5	64.8	58.8	5	78.6	70.5	3	496.6	496.2	5	487.9	480.3
Japan	1	225.7	225.7	1	252.7	252.7	1	998.1	998.1	1	794.2	794.2
Southeast Asia	13	49.4	37.9	13	63.6	48.3	3	307.7	239.2	10	437.7	356.9
Southwest Asia	15	22.2	9.6	15	29.2	13.0	6	118.9	99.0	8	125.8	106.0
South Central Asia	8	116.4	88.0	8	141.5	107.3	4	225.5	204.0	5	267.7	240.1
Northern Europe	7	155.4	46.0	7	160.5	48.2	6	169.6	134.2	6	186.1	133.3
Western Europe	6	164.6	125.0	6	180.5	136.5	6	171.5	132.3	6	182.7	125.5
Eastern Europe	6	100.0	89.6	6	104.3	98.0	6	111.1	108.8	6	109.0	106.0
Southern Europe	6	102.9	82.6	6	109.5	89.4	5	145.2	127.5	6	139.5	123.8
Australia-New Zealand	2	2.2	1.3	2	2.7	1.6	2	59.2	25.9	2	68.6	21.2
Oceania	6	5.5	3.6	6	7.4	4.7	4	149.7	122.4	2	220.1	219.0
U.S.S.R.	1	8.0	8.0	1	9.6	9.6	1	61.5	61.5	1	47.0	47.0

Table 30

AGRICULTURAL DENSITIES ACCORDING TO GEOGRAPHIC SUBREGIONS: 1950 AND 1960^a

(Densities are weighted by numerator--N--and denominator--(D)--values of the ratios.)

Subregion	ALF/ARABLE						ALF/AGRI					
	1950			1960			1950			1960		
	n (2)	N (3)	(D) (4)	n (5)	N (6)	(D) (7)	n (8)	N (9)	(D) (10)	n (11)	N (12)	(D) (13)
(1)												
Northern Africa	3	92.4	34.4	4	79.4	33.2	--	--	--	2	10.7	10.2
Western Africa	1	28.2	28.2	7	12.6	10.1	1	27.1	27.1	4	6.6	5.3
Eastern Africa	1	37.9	37.9	--	--	--	--	--	--	--	--	--
Middle and Southern Africa	1	91.2	91.2	2	43.7	29.1	1	5.6	5.6	1	0.2	0.2
South Africa (Republic)	1	18.2	18.2	1	13.0	13.0	1	1.6	1.6	1	1.5	1.5
Northern America	2	3.8	3.8	2	2.5	2.4	1	1.8	1.8	1	1.0	1.0
Middle America	8	26.6	23.2	7	25.9	23.8	7	9.4	5.7	7	7.6	5.8
Caribbean	5	100.9	59.8	4	53.5	48.7	4	59.1	43.1	4	29.4	27.5
Tropical South America	4	39.6	37.6	5	34.2	33.9	4	6.9	6.5	5	7.2	6.7
Temperate South America	3	12.9	8.1	4	14.3	9.6	2	1.9	1.4	3	2.0	1.3
East Asia	1	146.9	146.9	2	157.2	154.9	--	--	--	2	155.7	153.4
Japan	1	164.8	164.8	1	113.3	113.3	1	146.0	146.0	1	102.6	102.6
Southeast Asia	1	59.8	59.8	7	93.7	74.2	1	45.5	45.5	2	51.9	51.9
Southwest Asia	3	28.4	28.2	7	27.4	23.0	--	--	--	6	25.4	19.0
South Central Asia	4	48.7	43.5	5	59.8	53.0	1	37.9	37.9	1	45.2	45.2
Northern Europe	6	21.5	20.4	6	19.5	17.8	5	11.5	9.2	5	9.9	7.7
Western Europe	6	26.1	22.6	6	20.1	16.8	6	14.0	13.3	6	10.3	9.8
Eastern Europe	4	20.0	19.9	3	17.6	17.5	3	15.1	15.0	2	12.8	12.7
Southern Europe	4	33.6	32.3	6	27.3	26.5	2	26.6	25.7	5	17.1	15.9
Australia-New Zealand	2	10.1	4.8	2	8.4	4.1	2	0.3	0.1	2	0.3	0.1
Oceania	1	31.7	31.7	2	39.9	39.9	1	21.6	21.6	2	24.8	24.8
U.S.S.R.	--	--	--	1	7.9	7.9	--	--	--	1	3.0	3.0

^aExtension of Table 29.

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and

$$\text{Land Density} = \frac{\sum x_i}{\sum y_i}$$

When both types of densities are equal, then

$$\frac{\sum x_i}{\sum y_i} = \frac{1}{\sum x_i} \quad \sum \frac{x_i^2}{y_i} = k \text{ (constant)}$$

If each $x_i/y_i = k$, the above equation holds true. Hence if the densities are the same for all the countries in a region, the two types of weighted averages for the region will be equal. In other words, if the variation of densities (x_i/y_i) within a region approaches zero, the two types of weighted averages for the region tend to be equal.

Eastern Europe is an example of a region in which the population and the land RURAL/ARABLE densities are approximately equal (109.0 and 106.0 respectively)--see Table 29, columns (12) and (13). The population densities of the individual countries of Eastern Europe are as follows:

Population RURAL/ARABLE Density

	<u>1960</u>
Bulgaria	106.8
Czechoslovakia	139.7
East Germany	74.0
Hungary	105.3
Poland	96.0
Romania	120.7

The coefficient of variation for these densities is 0.19 (20.31/107.08).

At the other extreme is Northern Africa, where the population and the land RURAL/ARABLE densities in 1960 are 352.6 and 142.9 respectively. The individual population densities in Northern Africa are as follows:

Population RURAL/ARABLE Density

	<u>1960</u>
Algeria	107.4
Libya	41.8
Morocco	96.4
Tunisia	58.2
U.A.R.	662.1

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The coefficient of variation for these densities is 1.22 (235.68/193.17). The magnitude of the difference between the population and the land densities depends on the degree of concentration of the rural population on the arable land--i.e., the magnitude of the relative weights. The unusually high density of the rural population of the U.A.R. contributed significantly to the weighted population density of 352.6 in the region of Northern Africa. Further, 62.2 percent of the total arable land in the five Northern African countries is in Algeria and Morocco.

These examples of Eastern Europe and Northern Africa illustrate how differences between the two types of weighted averages for subregions are to be interpreted.

Northern America (Canada and the U.S.) shows the lowest population RURAL/ARABLE density (34.2 in 1960) among all the subregions. Its land RURAL/ARABLE density in 1960 is also one of the lowest; only Australia-New Zealand's is lower.

The population RURAL/ARABLE density in Middle America in 1960 is almost three times that in Northern America. The variation within the Middle America region is quite substantial, ranging from 72.3 in Mexico to 236.0 in El Salvador.

The Caribbean resembles Asia with regard to the population RURAL/ARABLE density in 1960. Haiti, Jamaica, and Puerto Rico are among the countries with the highest agricultural densities in the world. In Jamaica (where the data on arable land come from the agricultural census) the RURAL/ARABLE density increased from 397.6 to 513.1 during 1950-60, or by 29.0 percent. This is the result of a 15.3 percent decline in arable land¹⁴ and a 9.3 percent increase in the rural population during the decade.

¹⁴According to the agricultural census report, this decline is consistent with agricultural production figures: "The area under small farms (0-5 acres) has declined during 1954-61 (the root crops production has declined) but the area under larger farms has increased. This change in the farm-size distribution resulted in an increase of sugar cane and citrus production during the same period."

<u>Farm Size</u> (Acres)	<u>Cultivated Land (excluding fallow)</u> (Acres)	
	<u>1954</u>	<u>1961</u>
0-5	172,480	118,120
25-100	50,974	43,406
500+	162,638	190,471

Source: Department of Statistics, Agricultural

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In Tropical South America the densities are fairly high, particularly the land RURAL/ARABLE density--140.9 in 1960. The density level is extremely high in small countries of this region--e.g., 543.3 in French Guiana and 438.7 in Surinam. Colombia had an abrupt increase in density during 1950-60 (100.7 to 154.1), which can be attributed to a 14.9 percent increase in the rural population and a 25.0 percent decline in arable land during the ten-year period.

Temperate South America has very low levels of RURAL/ARABLE density. The population RURAL/ARABLE density (62.6) is significantly higher than the land density (45.1) in 1960 because of internal density variations ranging from 33.9 in Argentina to 180.1 in Paraguay.

The RURAL/ARABLE densities in East Asia and Japan are very high. South Korea has a population density of 953.4 in 1960, the highest in the world. In Japan the RURAL/ARABLE density fell by 20.4 percent during 1950-60 (from 998.1 to 794.2), a very substantial decline in a period of ten years. It is attributable to a 15.5 percent increase in arable land and an 8.0 percent decline in the rural population during the decade.

The Southeast Asia subregion has agricultural densities almost as high. Indonesia has the highest population density (587.5) in the region in 1960, and ranks fourth among the countries of the world. Sarawak, which has as much arable land as South Vietnam or Cambodia, is an exception to the region, with an extremely low population density of 33.9 in 1960.

The population and land RURAL/ARABLE densities in South Central Asia are about one-half those in East Asia. There are two distinct groups of countries in this region--one consisting of India and West Pakistan, with a population density level around 220, and the other of Ceylon, East Pakistan, and Nepal, with density levels ranging from 500 to 580. The population density in East Pakistan is the fifth highest among all the countries in the world, but the weighted averages of this region are heavily dominated by the levels in India. (The density levels in India and Pakistan are given in Chapter IV above--p. 121.

In contrast to the other regions of Asia, Southwest Asia has a relatively low RURAL/ARABLE density, partly because of its

Census 1961-62, Jamaica, Bulletin No. 4, 1961,
pp. iii-iv and p. 25.

This example illustrates the importance of farm-size distribution and agricultural production data. However, such aspects of land utilization are beyond the scope of the present study.

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higher level of urbanization. However, variation within the subregion is substantial: in Lebanon the density is 433.1; in Iraq and Syria, around 50.

The population RURAL/ARABLE densities in 1960 are less than 200 in all the subregions of Europe. However, the average population density level in Northern and Western Europe is about 50 percent higher than in Eastern and Southern Europe. On the other hand, land RURAL/ARABLE densities are fairly similar in all European subregions--around 125.0.

The fact that the population RURAL/ARABLE densities in Northern and Western Europe are significantly higher than the land densities indicates considerable variation within these regions. In Northern Europe the densities are quite low in Denmark, Finland, and Sweden (less than 90 in 1960) and quite high in Norway and the U.K. (more than 200). Western Europe has even greater variation. Switzerland, where the density is 568.0 in 1960, resembles an Asian country, while France--the largest country in the region--has a density of 81.7.

Australia, with a population RURAL/ARABLE density of 15.2 in 1960,¹⁵ joins Canada in having the lowest density among all the countries studied.

Since the proportion of the farm population in rural areas (FARM/RURAL) may differ in different regions, RURAL/ARABLE densities may exaggerate agricultural densities in those regions where the non-farm population is a significant part of the rural population. As noted in Chapter III, the concept of farm population is especially important where the agricultural system is highly mechanized; but lack of data on such populations limits the computation of FARM/ARABLE densities. In the following tabulation, subregions were selected for which FARM/ARABLE densities could be computed for approximately the same number of countries as RURAL/ARABLE densities.

<u>Subregion</u>	<u>Number of Countries</u>	<u>Population FARM/ARABLE Density: 1960</u>	<u>Land FARM/ARABLE Density: 1960</u>
Northern America	2	8.5	8.3
Temperate South America	4	45.2	28.8
Northern Europe	6	48.1	44.0
Western Europe	6	64.0	51.2
Southern Europe	6	86.4	81.2
Australia-New Zealand	2	25.8	10.2

¹⁵See footnote 6, Chapter IV.

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In most of the subregions not included in this table, the proportion FARM/RURAL is quite high--more than 75 percent. In Chapter III we saw that the subregions where the proportion of the farm population within the rural population is less than 50 percent are Northern America, Northern Europe, Western Europe, and Australia-New Zealand, whereas it is about 65 percent in Temperate South America and Southern Europe. Given such farm population levels, the RURAL/ARABLE densities would appear to overestimate the size of the agricultural population in relation to the arable land. The FARM/ARABLE density tabulation shows that the North American subregion has extremely low FARM/ARABLE densities--only 8 persons belonging to farm households per km² of arable land in 1960. The region with the second lowest densities is Australia-New Zealand, where the population FARM/ARABLE density is 25.8 but the land FARM/ARABLE density is almost at the North American level.

The European FARM/ARABLE densities are much lower than their RURAL/ARABLE densities. The population RURAL/ARABLE density in Northern Europe is 33 percent higher than in Southern Europe. But when we subtract the non-farm population from the rural population, the resulting agricultural density (the population FARM/ARABLE density) in Northern Europe is 44 percent below that in Southern Europe, which is what one would expect in view of the comparative economic levels of Northern and Southern Europe. Thus the FARM/ARABLE densities more accurately reflect the agricultural population/arable land ratios than do the RURAL/ARABLE densities.

Variations in ALF/ARABLE Densities According to Geographic Subregions

The statistics relevant to this section are shown in Table 30, columns (1)-(7). The discussion in the previous section of variations in RURAL/ARABLE and FARM/ARABLE densities by geographic subregions covers the important aspects of differences in these densities, but the ALF/ARABLE density is a superior comparative measure to either the RURAL/ARABLE or the FARM/ARABLE density. Its usefulness is limited by lack of coverage in certain subregions--particularly East Asia, Eastern Europe, and all subregions of Africa except Northern Africa. However, the overall comparative situation is essentially the same as that for RURAL/ARABLE and FARM/ARABLE densities, though in some instances the degree of variation may differ.

In 1960 there are only 2.5 agricultural workers employed on a km² of arable land in Northern America; the comparable statistic for Japan is 113.3. The example of Northern America shows how much effect the mechanization of agriculture and extensive industrial inputs in agriculture can have. The extremely low densities in South Africa, Australia-New Zealand, and the

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U.S.S.R. reflect the sophistication of the agricultural systems in those countries.

The Northern American subregion not only has the lowest ALF/ARABLE densities in 1960, but also showed a very substantial decline during 1950-60. The population density declined from 3.8 to 2.5, or by 34.2 percent, due mainly to a decline in the agricultural labor force--an illustration that the agricultural sector is unable to withstand competition from the nonagricultural sector. If the trend of the 1950-60 decade continues, agricultural density in Northern America may be reduced to less than 0.5 agricultural workers per km² of land by the end of the twentieth century.

The population and the land ALF/ARABLE densities in Middle America are about one-half the corresponding densities in the Caribbean. There was no change in the ALF/ARABLE density in Middle America during 1950-60.

The population ALF/ARABLE densities of the Caribbean region are 100.9 and 53.5 in 1950 and 1960 respectively. Such an extreme contrast is due primarily to the lack of data in 1960 for Haiti, which in 1950 had a very significant influence on the weighted average. The ALF/ARABLE density of Haiti in 1950 is 204.9--the highest level shown by any country in 1950. (The second highest level in 1950 is 164.8, in Japan.) Puerto Rico had a dramatic decline of population ALF/ARABLE density from 68.2 to 43.9 during 1950-60, in marked contrast to a small rise in RURAL/ARABLE density (from 435.5 to 461.3). The ALF/ARABLE decline was mainly the result of a reduction in the agricultural labor force.

The ALF/ARABLE densities are very high in East Asia, Japan,¹⁶ and Southeast Asia. The average population ALF/ARABLE

¹⁶ The ALF/ARABLE density in Japan declined from 164.8 in 1950 to 113.3 in 1960, or by 31.3 percent--substantially more than the decline of 20.4 percent in RURAL/ARABLE density. Japan's ALF declined from 8.62 million to 6.85 million during the decade, or by 20.5 percent. Therefore, the remaining part of the decline in ALF/ARABLE density is due to an increase in arable land. It is difficult to say whether the decline in ALF was due to an extremely high original density or to the rapid industrialization during the postwar period. Certainly the agricultural sector was terribly overcrowded in 1950. Japan's 1950 level of ALF/ARABLE density (i.e., 164.8) was the second highest among the countries for which data were available. Closely following Japan was the U.A.R. (138.2) in 1950. In contrast to Japan, the density in the U.A.R. increased to 144.6 in 1960. If high density is a

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density in these regions in 1960 is about 115. In Southwest Asia, by contrast, the population ALF/ARABLE density in 1960 is 27.4.

fundamental cause of outmigration of ALF, there should have been a decline in the size of ALF in the U.A.R. This was not the case; the ALF in the U.A.R. increased by 8.7 percent, with a minor change in the relative size of ALF. This suggests that though the potential for outmigration of ALF existed in both Japan and the U.A.R., the industrialization of Japan made the difference. (This aspect will be elaborated in the next chapter.)

One indication of "overpopulation" in the agricultural sector of Japan is the average size of farm holdings, as illustrated in the following comparative tabulation for 1960:

Country ^a	Average Size of Holding (hectares)	Percent of Total Agricultural Area in Holdings of Specified Size ^b
Japan	1.2	3.0% in 20+ hectares
Sarawak	1.8	6.4% in 40+ hectares
Argentina	371.1	99.0% in 25+ hectares
Costa Rica	41.1	90.1% in 20.7+ hectares
Puerto Rico	14.4	71.5% in 19.7+ hectares
U.S.	122.6	97.9% in 20.2+ hectares
Pakistan	2.3	31.1% in 10.12+ hectares
Ireland	16.1	66.5% in 20.2+ hectares
Austria	19.4	73.6% in 20+ hectares
Poland	46.8	5.7% ^c in 20+ hectares
Thailand	3.5	3.7% in 22.4+ hectares
Turkey	5.0	27.3% in 20.1+ hectares
Australia	1843.6	99.9% in 20.2+ hectares

^aThe list is limited by both necessity and choice: first, data by size of holding are not available for many countries, particularly in Asia and Africa; second, the primary aim is to show comparative levels by selecting countries from several of the major subregions.

^bThe specific size limits used are dictated by the available size-distribution data.

^cFor private (individual) holdings only.

Source: Computed from data for specific countries in F.A.O. Report of the 1960 World Census of Agriculture, Vols. 1/a and 1/b.

The population ALF/ARABLE density in South Central Asia in 1960 (59.8) approximates the average density level of the world as a whole. India had a 23.1 percent increase in density during 1950-60, due mainly to a 27.3 percent increase in the agricultural labor force. Thus India, along with the U.S., Puerto Rico, and Japan, illustrates that dramatic declines or rises in agricultural densities have been due primarily to changes in agricultural labor forces rather than to expansions of arable land.

The population ALF/ARABLE densities in European regions are fairly low--about 20 agricultural laborers per km² of arable land in 1960. Although the population ALF/ARABLE densities in Northern and Western Europe are almost exactly the same in 1960, the population FARM/ARABLE densities are 48.1 and 64.0 respectively (p. 175). Such a contrast between the two measures is

The history of Japanese agricultural development is a peculiar one. In the middle of the nineteenth century, the Meiji rulers adopted a policy of rapid industrialization based on heavy taxation of the agricultural sector, which was not very productive. Such a policy is politically impossible in contemporary less developed countries. Wilkinson summarizes the peculiar history of industrialization in Japan as follows:

The similarity between Japan and the West with respect to statistical indices of relationship of industrialization and urbanization is heavily qualified, however, by the unique features of Japan's pre-modern socioeconomic structure, which has been influential upon the character of her industrialization. Japanese modernization was accomplished without seriously disturbing many of the feudal-agrarian elements of her social organization. For instance, Japanese industrial management was able to integrate traditional feudal values, e.g., personal loyalty and subservience of subordinate to superior, into the organization of modern industrial activities. The individualism characteristic of industrialization in the West has been largely absent in Japan. Japanese society remains essentially a familial hierarchy which binds the individual to the nation through a series of traditionally defined social relationships. . . . Significant inroads in this traditional pattern have been made by the host of Western, and specifically American, elements introduced widely in Japan during and after the Occupation, but the "old" Japan is still strong and viable in this regard, and contrasts with the Western prototype remain valid.

He reproduces Japanese census results showing the trend of labor force structure from 1920-60:

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obviously due to differences in the FARM/ALF ratios. The weighted FARM/ALF ratios in Northern and Western Europe in 1960 are 2.5 and 3.0 respectively. From Appendix Table VII we can cite a few examples:

	<u>ALF/ARABLE</u>	<u>FARM/ARABLE</u>
Norway	30.5	64.3
U.K.	21.5	74.7
Austria	22.4	69.5
Belgium	25.1	114.3

The FARM/ARABLE densities show greater variation than the ALF/ARABLE densities. Why is the FARM/ARABLE density in Belgium 65 percent higher than that in Austria, when their ALF/ARABLE densities are approximately the same? I cannot provide a satisfactory answer.

Using the equation from p. 162 and the computational method illustrated in Tables 27 and 28, we obtain the following ALF/CULTIVATED densities in those subregions where pastoral activities are important:

<u>Year</u>	<u>Percent of Economically Active Males in Non- Agricultural Occupations</u>
1920	51.8
1930	57.0
1940	64.3
1950	59.8
1955	66.2
1960	74.4

Source: Thomas O. Wilkinson, The Urbanization of Japanese Labor, 1868-1955 (Amherst: University of Massachusetts Press, 1965).

Of the several other publications dealing with the history of agricultural development in Japan, the following two are exceptionally good: Bruce F. Johnston, Agricultural and Economic Development in Japan: Its Relevance to the Developing Nations (Food Research Institute Studies No. 6, Stanford University, 1966); and Ogura Takeazu, Agriculture Development in Modern Japan (Tokyo: Fuji Publishing Co., 1963).

AGRICULTURAL DENSITY: AGRICULTURAL POPULATION/AGRICULTURAL LAND

<u>Subregion^a</u>	<u>Population ALF/CULTIVATED Density: 1960 (Estimated)</u>
Northern America	2.1
Tropical South America	21.0
Temperate South America	10.2
Northern Europe	11.9
Western Europe	15.5
Eastern Europe	15.7
Southern Europe	24.8
Australia-New Zealand	3.3

^a Middle America is omitted from the list because statistics on cultivated pasture for Mexico are not available.

Sources: (1) CULT PAST/PAST and ARABLE/AGRI ratios from Table 24, Chapter IV; (2) Population ALF/ARABLE densities from Table 30, Chapter V.

When we incorporate cultivated pasture into arable land, we find that the greatest reductions in ALF/ARABLE densities take place in Tropical South America and Northern Europe. The ALF/CULTIVATED densities in these regions are about 60 percent less than the corresponding ALF/ARABLE densities. The ALF/CULTIVATED densities for the Australia-New Zealand subregion are much closer to those of Northern America than were the ALF/ARABLE densities.

Chapter VI

THE THEORY OF GROWTH OF THE AGRICULTURAL LABOR FORCE

One of the principal aims of this study is to explain the growth of the agricultural population. In earlier chapters, particularly in Chapter III, we proposed various reasons for the growth of the agricultural populations of countries at different economic levels and in different geographic regions. We summarized some of the main determinants of this growth: the rate of natural increase of the population, the demand for agricultural products, the level of incomes in the agricultural and nonagricultural sectors, and the productivity of agricultural labor. We specified four reasons why the rate of growth of the agricultural labor force in countries at economic level 4 is much lower than in those at economic levels 1, 2, and 3: (1) the rate of growth of the total population is lower in countries at economic level 4; (2) there is a higher demand for labor from the nonagricultural sector in countries at economic level 4 because they are, by definition, at a higher level of industrialization than countries at the other economic levels; (3) the demand for labor from the nonagricultural sector in the highly developed countries is likely to be greater than the supply of labor from natural increase in urban areas [in essence, a corollary of reasons (1) and (2)]; and (4) the size of the agricultural labor force in countries at economic level 4 is small (about 20-30 percent of the total labor force), so that even a moderate pull by the larger nonagricultural sector is reflected in a low rate of growth of the agricultural labor force (essentially a statistical reason).

The analysis in Chapter III showed conclusively that the higher the economic level of a country, the lower the proportion of its population in the agricultural labor force and in the rural category. It also showed (Table 17) that the rates of growth of the rural population, the agricultural labor force (ALF), and the farm population are negatively associated with economic level. The data concerning the ALF--the best indicator of the size of the agricultural population--are the most informative. The ALF increased by a (weighted) average of 23 percent during 1950-60 in countries at economic level 2, whereas it declined by 23 percent in countries at economic level 4. The same kind of relationship was revealed in our analysis by subregion: the subregions consisting of countries at the higher economic levels showed lower proportions of agricultural population and lower growth rates of the agricultural population than the subregions made up of countries at the lower economic levels. These results indicate

that the process of economic growth in general, and of industrialization in particular, is the fundamental determinant of the size and growth of the ALF. In this chapter, we shall attempt to substantiate this conclusion through regression analysis.

Before proceeding to our analysis, we should consider another possible explanation of the growth of the ALF--namely, the "push factors" of rural-urban migration (to be more specific: agricultural to nonagricultural migration). According to this hypothesis, when pressure on agricultural land continues to rise because of the growth of the agricultural population, that population moves to nonagricultural pursuits. Outmigration thereby reduces growth. If this hypothesis holds, we should find a substantial negative correlation between agricultural density and growth of the ALF. Petersen summarizes the hypothesis as follows:

A primitive migration (a migration typology--a type of migration caused by ecological push) of an agrarian population takes place when there is a disparity between the produce of the land and the number of people subsisting from it. This can come about either suddenly, as by drought or an attack of locusts, or by the steady pressure of growing numbers on land of limited area and fertility. Persons induced to migrate by such population pressure can seek another agricultural site elsewhere, but in the modern era the more usual destination has been a town. That is to say, the migration has ordinarily been innovating rather than conservative. The Irish immigrants to the United States in the decades after the Great Famine, for example, resolutely ignored the Homestead Act and other inducements to settle on the land; in overwhelming proportion, they moved to the cities and stayed there. Let us term such an innovating movement flight from the land (again an inelegant but useful translation from the German).¹

By utilizing the agricultural densities calculated in Chapter V, we shall try to assess the significance of agricultural density as the push factor for outmigration of the ALF from agriculture through the regression analysis.

In our general theory of change in the agricultural population, we must incorporate certain conclusions concerning agricultural land derived in Chapter IV. We saw there that under the pressure of increasing population (and consequently of increasing agricultural density), the proportion of fallow to arable land tends to decline--i.e., arable land is cultivated more intensively. If agriculture is not significantly mechanized, more intensive cultivation will absorb the additional labor input resulting

¹William Petersen, Population, p. 293.

from natural population increase. In other words, increased population/agricultural density does not necessarily cause out-migration of the agricultural population, and hence its growth is not affected. In Chapter IV we also saw that there is a positive relationship between the proportion of arable land to total agricultural land and population density. This seems to indicate that when the population increases, pasture--in particular, cultivated pasture--is converted into arable land. Since labor requirements are greater on arable land than on pasture, more labor is absorbed in agriculture when the proportion of arable land (ARABLE/AGRI) is increased. A country with a low ARABLE/AGRI ratio has considerable potential for absorbing a growing ALF. Translated into a cross-sectional hypothesis, this means that we can expect a negative relationship between the growth rate of the ALF and the proportion of arable land (ARABLE/AGRI). The ARABLE/AGRI ratio (thus qualified) becomes one of the four variables in our regression analysis.

Regression Analysis with the Rates of Growth of the ALF as the Dependent Variable

In performing our regression analysis, using the rates of growth of the ALF during 1950-60 as the dependent variable, we have relied wholly on data already introduced in this study. Thus, in selecting independent variables, we have been limited to factors discussed in earlier chapters. As a result, some important variables, such as the productivity of agricultural land, the productivity of the agricultural labor force, comparative incomes of the agricultural and nonagricultural sectors, and the fertility and mortality levels of the agricultural and nonagricultural populations, have not been included. We will, however, introduce new data concerning the productivity of the ALF and of arable land in the discussion following the regression analysis.

We have selected the following variables for our regression equations:

- (0) Growth of the agricultural labor force: This is indicated by the ratio of the ALF in 1960 to the ALF in 1950 (y). The percent growth during 1950-60 is $(\text{ratio} - 1) \times 100$.
- (1) Economic level: The economic level of a country is represented by $\log_e \left[\frac{\text{Electricity Production in 1960}}{\text{Total Population in 1960}} \right]$ in all forms of regression equations (x_1). The logarithm of per capita electricity production in 1960 was used to divide our sample of countries into five broad economic groups (see Chapter II, pp. 37-38).
- (2) The ALF/ARABLE density in 1960 (x_2).

- (3) Composition of agricultural land: This variable is shown by the percent of arable land to total agricultural land in 1960--i.e., $ARABLE/AGRI$ in 1960 (x_3).
- (4) Absolute size of the agricultural population: This variable is necessary for comparing the growth of the agricultural populations in two countries. A 20 percent increase in the ALF in the U.K., for example, has quite different implications than a 20 percent increase in India. Further, growth patterns of agricultural populations may differ according to the size of the population. We have represented the size in logarithms--i.e., $\log_e$ (rural population in 1960)--in all forms of regression equations (x_4).

There are only 59 countries possessing data on variables (1), (2), and (4). Among these 59, however, 14 do not have data on variable (3)--the $ARABLE/AGRI$ ratio. In order to maintain the sample size at 59, we have assigned arbitrary values of $ARABLE/AGRI$ proportions to each of these 14 countries, corresponding roughly to the ratios in some neighboring countries or in the geographic subregion in which the country lies. Six of the 14 countries are in the Southeast and South Central subregions of Asia, where pasture is unimportant. (We would have liked to include $FALLOW/ARABLE$ proportions in the regression equations, but this would have meant assigning arbitrary ratios to 25 countries--too large a number for a total sample of 59.)

The 14 countries and the arbitrary values of $ARABLE/AGRI$ assigned to them are as follows:

Country	$\frac{ARABLE}{AGRI} \times 100$ (Arbitrary value: 1960)	Remarks
Morocco	60.0	The mean value of levels in Algeria, Libya, and Tunisia.
U.A.R.	98.0	
Israel	80.0	The level in Cyprus.
Malaya	95.0	The average level in Southeast Asia.
Philippines	60.0	A low value is assigned because of the significant proportion of cultivated pasture in the Philippines.
Ceylon	95.0	This is slightly higher than in India (92.0).
Nepal	80.0	Nepal is primarily a mountainous country, with most agricultural land in the valleys.

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East Pakistan	95.0	Corresponds to the Indian level.
West Pakistan	95.0	Corresponds to the Indian level.
Canada	30.0	The comparable U.S. level is 41.0 in 1960.
Paraguay	15.0	Corresponds to the level in Temperate South America.
Ireland	60.0	Because arable farming is very important in Ireland, this ratio is higher than the average in Northern Europe (45.2).
Poland	75.0	The average level in Eastern Europe.
Portugal	60.0	The average in Southern Europe.

Results of the Regression Analysis

Table 31 shows the results of the regression analysis with growth of the ALF during 1950-60--ALF 1960/ALF 1950--treated as the dependent variable. Three forms of regression equations were used, which we label:

Linear: $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + e$

Loglinear: $\ln y = \beta_0 + \beta_1 x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 x_4 + e$

Semilog: $y = \beta_0 + \beta_1 x_1 + \beta_2 \ln x_2 + \beta_3 \ln x_3 + \beta_4 x_4 + e$

The variables in these equations are defined in Table 31. It should be noted that x_1 and x_4 are already in logarithms, and therefore additional transformations were not applied. The last term in the regression, e , is the error term. In order to be able to use the usual parametric tests, it is necessary to assume that the x 's can be treated as non-stochastic and that the error vector e is distributed ($N(0, \sigma^2 I)$).

In Table 31 we show the corrected coefficient of multiple determination, $\bar{R}^2$, rather than the uncorrected coefficient, R^2 . The correction for degrees of freedom² is as follows:

$$\bar{R}^2 = \text{Maximum} \left[1 - (1 - R^2) \frac{N - 1}{N - K - 1}, 0 \right],$$

²David Elesh, "Methodological Inadequacies in Quantification of Case-Study Data," The American Sociologist, Vol. IV, No. 4 (November 1969), p. 338.

Table 31

REGRESSION RESULTS FOR GROWTH OF AGRICULTURAL LABOR FORCE AS THE DEPENDENT VARIABLE:
1950-1960

Region ^a	Number of Countries	Form	R^2 ^b	Constant Term	Independent Variables ^b			
					x_1	x_2	x_3	x_4
All Regions	59	Linear	0.553 (18.974) ^c	193.234 (9.232)	-9.7820 (-7.923)	-0.0676 (-0.960)	-0.1515 (-2.075)	-1.5145 (-1.211)
		Loglinear	0.554 (19.027)	5.820 (22.764)	-0.0961 (-7.036)	-0.0002 (-0.009)	-0.0850 (-2.485)	-0.0212 (-1.659)
		Semilog	0.558 (19.277)	216.857 (8.908)	-9.2135 (-7.086)	-0.0384 (-0.016)	-8.3722 (-2.571)	-1.8504 (-1.524)
Europe	20	Linear	0.322 (3.256)	146.327 (3.054)	-8.0813 (-3.410)	0.2047 (0.918)	0.1399 (0.937)	-1.2943 (-0.572)
		Loglinear	0.251 (2.591)	5.224 (6.687)	-0.0924 (-2.987)	0.0231 (0.382)	0.0274 (0.306)	-0.0217 (-0.775)
		Semilog	0.290 (2.943)	145.249 (2.307)	-7.8204 (-3.136)	2.5268 (0.517)	3.1155 (0.432)	-1.7449 (-0.771)
Asia and Other	18	Linear	0.212 (2.144)	92.965 (2.111)	-4.2462 (-1.965)	-0.0537 (-0.588)	-0.2040 (-1.154)	3.4320 (1.428)
		Loglinear	0.206 (2.101)	4.8668 (9.117)	-0.0440 (-2.123)	-0.0324 (-0.611)	-0.0784 (-0.970)	0.0296 (1.206)
		Semilog	0.189 (1.990)	121.1932 (2.096)	-4.4263 (-1.973)	-3.5864 (-0.623)	-7.8606 (-0.898)	3.4576 (1.299)

Table 31 (continued)

Region	Number of Countries	Form	$\bar{R}^2$	Constant Term	Independent Variables			
					x_1	x_2	x_3	x_4
Frontier Countries	21	Linear	0.577 (7.822)	216.472 (5.362)	-14.7496 (-4.733)	-0.4231 (-1.552)	-0.0502 (-0.358)	-0.6896 (-0.270)
		Loglinear	0.512 (6.243)	5.967 (11.177)	-0.1557 (-3.222)	-0.0462 (-0.796)	-0.0352 (-0.571)	-0.0095 (-0.335)
		Semilog	0.536 (6.766)	219.744 (4.579)	-14.2356 (-3.277)	-3.4325 (-0.657)	-2.8532 (-0.514)	-0.5629 (-0.221)

^aThe following countries comprise the three regional groups:

Europe: Denmark, Finland, Ireland, Norway, Sweden, U.K., Austria, Belgium, France, West Germany, Netherlands, Switzerland, East Germany, Hungary, Poland, Greece, Italy, Portugal, Spain, Yugoslavia.

Asia and

Taiwan, Japan, Malaya, Philippines, Thailand, Cyprus, Israel, Turkey, Ceylon, India, Nepal, East Pakistan, West Pakistan, Algeria, Morocco, Tunisia, U.A.R., South Africa.

Frontier

Canada, U.S., British Honduras, Costa Rica, El Salvador, Honduras, Mexico, Nicaragua, Panama, Dominican Republic, Puerto Rico, Trinidad and Tobago, Brazil, Colombia, Venezuela, Argentina, Chile, Paraguay, Australia, New Zealand, Fiji.

^b

x_1 = Economic level--log(per capita electricity production in 1960).

x_2 = Agricultural density--(ALF/ARABLE 1960).

x_3 = Proportion of arable land to agricultural land--(ARABLE/AGRI 1960).

Table 31 (continued)

x_4 = Size of rural population--log(rural population in 1960).

R^2 = Coefficient of multiple determination (adjusted for degrees of freedom).

The figures in parentheses in the independent variables columns are t-ratios. The t values corresponding to several probability levels for two-tailed significance tests are set out below.

Degrees of Freedom	Probability Level		
	.10	.05	.01
13	1.77	2.16	3.01
15	1.75	2.13	2.95
16	1.75	2.12	2.92
54	1.67	2.00	2.67

^cThe figures in the parentheses are F-statistics (= $F_{(K, N-K-1)}$). These are used in testing $H: \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$. The F-ratios corresponding to several probability levels are set out below.

Degrees of Freedom	Probability Level		
	.10	.05	.01
(4, 54)	2.06	2.56	3.71
(4, 13)	2.43	3.18	5.21
(4, 15)	2.36	3.06	4.89
(4, 16)	2.33	3.01	4.77

where R^2 is the uncorrected coefficient of multiple determination (R^2 measures the proportion of total variation about the mean value $\bar{y}$ "explained" by the regression equation), N is the number of observations, and K is the number of independent variables in the regression equation. Thus the lower the value of $(N - K)$, the greater the difference between corrected and uncorrected R^2 . Consequently, the correction for degrees of freedom is important when the sample size is small.

In testing the significance of R^2 and of the individual coefficients, we generally use the 10 percent level of significance rather than the usual 5 percent. General theories and statements are usually more conditional and qualified in the social sciences than in the physical sciences, so that more latitude is tolerated in the former than in the latter. Furthermore, the extent of error in basic social sciences data is usually greater than that in data used in the physical sciences (particularly in data obtained through laboratory experiments). Therefore it seems inadvisable to apply the strict standards employed in the physical sciences (and those used in agricultural experiments based on the principles of "design and experiments" as initiated by Fisher, who first popularized the use of 1 percent and 5 percent significance levels) to the social sciences. We shall use a 10 percent level of significance, though it should be noted that this is not a widespread practice in the social sciences.³

In Table 31 we present the values of the t-statistic (in parentheses) that are used to test the statistical significance of the regression coefficients. This is in contrast to the more common practice of showing the estimated standard errors when presenting regression results.⁴ We note further that tabulated probability levels are not exactly applicable if separately computed t-ratios are used to test several regression coefficients in the same equation. Appropriate tests, based on simultaneous confidence regions, exist and can be used, provided that one decides beforehand (i.e., before estimating the equation) on the set of coefficients one will test simultaneously. Approximations

³ See Sanford Labovitz, "Criteria for Selecting a Significance Level: A Note on the Sacredness of .05," The American Sociologist, Vol. III, No. 3 (August 1968), pp. 220-222.

⁴ Standard errors can easily be calculated by using the definition of the t-statistic, $t_i = \frac{b_i}{(SE)_i}$, where the coefficient, b_i and its estimated standard error, $(SE)_i$, refer to the independent variable x_i .

also exist which do not require such prior commitment and permit one (at a cost of having to use rather wide intervals) to test individually several or all of the coefficients in the same regression equation.⁵

Regression Equations with the Rate of Growth of the ALF as the Dependent Variable

In the linear form of the regression equation for All Regions in Table 31, we find that $\bar{R}^2$ is 0.553, and thus highly significant.⁶ The given set of four independent variables accounts for 55.3 percent of the variation around the mean of the intercensal ratio of the agricultural labor force (ALF 1960/ALF 1950 $\times$ 100). Although statistically this is a significant accomplishment of the regression model, almost half of the variation is still unaccounted for. The remaining variation may be due to subtle nonlinearities of relationships, the effects of certain other major variables not included in the equation, errors in the basic data, or the lack of any relationship at all among the variables. It is conceivable that if more variables are added to the regression equation, some of the existing significant relationships will not remain significant; but until this is shown to be so, such a possibility must remain conjectural.

The coefficient of the economic level, x_1 , is highly significant--that is, the economic level of a country is a crucial variable associated with the rate of growth of its ALF. The coefficient of -9.782 means that when other factors remain unchanged, an increase in log (EP), x_1 , by 1 will decrease the intercensal ratio of the ALF by 9.782.

In the other forms of the regression equation in Table 31, the coefficient of the economic level is as highly significant and of the same sign as in the linear regression model. The coefficients in the loglinear regression equation can be regarded as elasticity measures.⁷ The elasticity of the economic level is -.0961--that is, for each 1.0 percent rise in the economic level (here measured by the absolute electricity production rather than by log (EP) as in the linear equation), the intercensal ratio

⁵Multiple comparisons and simultaneous confidence intervals are discussed extensively in Rupert G. Miller, Jr., Simultaneous Statistical Inference (New York: McGraw-Hill, 1966).

⁶See notes to Table 31; the test actually refers to R^2 .

⁷Glenn G. Cain, Married Women in the Labor Force (Chicago: University of Chicago Press, 1966), p. 49.

of the ALF will decline by .0961. This may appear to be a very minor change, but in reality it is quite important, since electricity production increased from two to five times between 1950 and 1960 in the majority of countries in the sample.

The coefficients of agricultural density, x_2 , are not significant in any form of regression models for All Regions. Thus when the effects of other variables, particularly economic factors, are controlled, agricultural density has practically no influence on the growth of the ALF.

The coefficient of x_3 , the proportion of arable land, is significant at the 5 percent level in all forms of the regression model. The negative sign of this coefficient is consistent with the hypothesis stated on p. 184 above. This relationship is particularly interesting when we consider that the zero-order correlation coefficient between the growth rate of the ALF and the proportion of arable land is almost nil ($= -0.0476$).⁸ Thus it is only after controlling for the effect of economic factors and the size of the rural population that the proportion of arable land is an important variable associated with the growth of the ALF.

The coefficient of x_4 , the size of the rural population [$\log$ (rural population in 1960)], is almost significant at the 10 percent level in the loglinear model and not significant in the other two equations. In all equations the sign is negative, which means that the larger the size of the agricultural population, the smaller is the rate of growth of the ALF. In most countries in our sample the proportion ALF has declined during 1950-60, and in particular, the overall growth of the ALF in countries of economic level 4 (which is overrepresented in our sample) is negative. According to these results, the larger the size of the agricultural population, the greater the decline in the ALF. Again, the zero-order correlation coefficient between the growth rate of the ALF and the size of the rural population is almost zero ($= 0.0678$).

Results by Geographic Region. In order to detect geographic patterns in relationships, we performed the regression analysis by geographic regions as well; Table 32 provides the results. Inevitably there was a considerable reduction in the size of samples--i.e., in a loss in degrees of freedom. With the exception of Frontier Countries, the fit of the regression equations by regions is considerably lower than it is for the pooled data. One possible reason for this is the smaller variability

⁸By contrast, the correlation coefficient between the growth of the ALF and economic level is -0.6617 .

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Table 32

COEFFICIENTS OF VARIATION OF VARIABLES IN THE REGRESSION
ANALYSIS BY REGION

Variable	All Regions	Europe	Asia and Other	Frontier Countries
(1) $\left(\frac{\text{ALF } 1960}{\text{ALF } 1950} \times 100\right) = y$	.2056	.1474	.1514	.1919
(2) $\log\left[\frac{\text{ALF } 1960}{\text{ALF } 1950} \times 100\right] = y$	.0471	.0323	.0330	.0484
x_1	.2936	.1154	.3750	.2296
x_2	1.0108	.5969	.7241	.7352
x_3	.4026	.2543	.1861	.5941
x_4	.0993	.0576	.1102	1.0427
$\log(x_2)$	.3264	.1797	.2061	.4301
$\log(x_3)$	.1486	.0813	.0471	.2006

Note: See Table 31 for definitions of x 's.

of data within regions. The coefficients of variation (standard deviation/mean) cited in Table 32 are comparable among themselves because they are independent of the units of measurement of the characteristics.⁹

⁹One factor hindering comparison is the size of the sample. The larger the sample, of course, the greater the reliability of the coefficient of variation. The approximate formula for the standard error of the coefficient of variation, V , is:

$$V \sqrt{\frac{1 + 2V^2}{2n}}$$

(C.E. Weatherburn, A First Course in Mathematical Statistics [London: Cambridge University Press, 1946], p. 144).

Thus the standard error is directly proportional to the magnitude of the coefficient of variation, and inversely proportional to the size of the sample. Since the sample sizes for Europe, Asia, and the Frontier Countries are approximately the same, their standard errors are comparable. As an illustration, the standard errors of the coefficient of variation of the dependent variable are as follows:

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The basic purpose of regression analysis is to account for the variation in the dependent variable. The variability of y , in Europe and Asia, as measured by the coefficient of variation, is substantially less (by about 25 percent) than in All Regions and Frontier Countries. In other words, the variations in Europe and Asia to be explained by a regression model are small; with respect to the rate of growth of the ALF, these regions are quite homogeneous. Thus the growth rates of the ALF, for example, in European and Asian countries are more or less undetermined by the other independent variables in our regression equations.

This discussion about Europe and Asia indicates that other independent variables are needed in the regression analysis, such as (perhaps) the incomes of the agricultural and nonagricultural sectors and the previous levels of growth of the ALF. However, further research along these lines is beyond the scope of this study.

Because of the extremely high agricultural densities in some Asian countries, a significant negative coefficient of the agricultural density variable, x_2 , was to be expected. The growth of the ALF appears to be independent of the level of agricultural density, however--a major blow to the push-theory of migration.

In contrast to the results for Europe and Asia, $\bar{R}^2$ for the Frontier Countries (the Americas plus Australia-New Zealand) show a high level of significance. (The linear model produces better results than the loglinear.) This region includes highly developed countries in Northern America, Temperate South America, and Australia-New Zealand, on the one hand, and subregions with less developed countries (economic levels 2 and 3), on the other. The pattern of rates of growth of the ALF follows the same variation (see Table 18 in Chapter III and pp. 96-99). The zero-order correlation coefficient between the growth of the ALF and economic level is high (-.7410).

The Maximization of $\bar{R}^2$. The results in Table 31 are derived by using pre-selected independent variables. It is not

Coefficient of Variation (V) + S.E. (V)

All Regions	.2056 $\pm$.0062
Europe	.1474 $\pm$.0238
Asia and Other	.1514 $\pm$.0259
Frontier Countries	.1919 $\pm$.0307

Even though the coefficient of variation is about the same for All Regions and Frontier Countries, that for the former is more reliable.

necessarily the case that we obtain the most efficient regression equation (a maximum $\bar{R}^2$) by retaining all these variables. The uncorrected coefficient of multiple determination, R^2 , is often used as a convenient measure of the success of the regression equation. But as Draper and Smith state:

Given that the number of observations is much greater than the number of potential X variables under consideration, the addition of a new variable will always increase R^2 but it will not necessarily increase the precision of the estimate of response.¹⁰

In other words, the addition of a new variable can never reduce the value of R^2 . In order to see whether a new variable might increase the precision of the regression equation, we can use the corrected multiple coefficient of determination, $\bar{R}^2$, and values of the t-statistic.

It has been proven that " $\bar{R}^2$ will increase when a single variable is removed from a regression equation if and only if the corresponding t-statistic is less than unity."¹¹ Thus, in order to maximize the value of $\bar{R}^2$, we should retain only those variables that have absolute value of t-statistic greater than unity. We can eliminate the independent variables with t-statistics less than unity and get the "best" regression equation. The results are presented in Table 33, which is of course based on the regression equations in Table 31. Three effects are especially notable.

First, the variable x_2 , agricultural density, is eliminated from all the regression equations except the linear regression equations for Europe and the Frontier Countries.¹² This

¹⁰ N.R. Draper and H. Smith, Applied Regression Analysis (New York: John Wiley and Sons, Inc., 1966), p. 118.

¹¹ A proof of this theorem can be found in Yoel Haitovsky, "A Note on the Maximization of $\bar{R}^2$," The American Statistician, Vol. III, No. 1 (February 1969), p. 20. The general theorem, of which the above theorem is a special case, is as follows: " $\bar{R}^2$ will increase when a group of variables are removed if and only if the corresponding F-statistic is less than unity" (John B. Edwards, "The Relation Between the F-test and $\bar{R}^2$," The American Statistician, Vol. XXIII, No. 5 [December 1969], p. 28).

¹² x_2 is retained in the linear equation for All Regions only because its t-ratio is nearly unity.

result strengthens the argument that agricultural density is not an important explanatory variable for the growth of the ALF in our sample of 59 countries.

Second, the economic level variable, x_1 , is highly significant in all the equations, particularly those for All Regions and Frontier Countries.

Third, $\bar{R}^2$ becomes significant in all regression equations for Asia.

In concluding this section we should point out that the adjustment of R^2 to produce $\bar{R}^2$ is essentially arbitrary and may have little substantive or statistical significance. A more important consideration is that standard probability levels are no longer applicable in a two-stage analysis of first determining the coefficients for which the t-ratio is less than one and then reestimating the remainder. However, it is rather difficult to determine the appropriate probability levels for such a procedure.

Discussion: The Growth of the ALF

Before we assess the theoretical importance of the regression results, we should call attention again to the bias inherent in the data on the ALF. The bias relates to the distribution of countries by region, and consequently by economic level, in our sample of 59 countries possessing data on the growth of the ALF and the four specified independent variables. The sample is proportionally overrepresented by countries in Europe and the "Frontier Region" (mainly the Americas), at the expense of countries in Asia and Africa. This uneven distribution by geographic region is reflected in an uneven distribution by economic level: countries at economic levels 4 and 3 are overrepresented at the expense of those at levels 2 and 1. There are only two countries at economic level 1 in our sample.

<u>Economic Level in 1960 [log (EP 1960)]</u>				
<u>Group</u>	<u>n</u>	<u>Mean</u>	<u>sd</u>	<u>Coefficient of Variation x 100</u>
ALF Sample	59	5.9501	1.7468	29.4
All Countries	138	4.8310	2.0515	42.5

The data for All Countries are reproduced from Chapter II (p. 37). Clearly the average economic level of a country in the ALF sample is much higher than that in the wider sample. This means that we cannot provide a systematic theory of change in the

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ALF that has universal significance. Rather, our discussion based on regression results for the growth of the ALF will pertain only to countries higher up the ladder of economic development.

The Significance of Economic Level

The general import of the regression analysis is that most of the variation in the growth of the ALF is associated with differences in economic levels. In Table 33, the significant negative values of the coefficients of x_1 in all forms of regression models firmly substantiate the conclusions from Chapter III summarized in the introductory section of this chapter--viz., the major determinants of growth of the ALF are the rate of natural increase of the population (in particular, of the agricultural population), the demand for agricultural products, the comparative income levels of the agricultural and nonagricultural sectors, and the productivity of agricultural labor. All these factors are, directly or indirectly, related to the general level of economic development.

It has been well established that the rate of growth of the total population is inversely related to the economic level of a country. Because of this relationship, the rate of growth of the total population would have been a redundant variable in the regression equations; hence it was not included. At this stage, however, there is a positive argument for including it, which can best be illustrated by a hypothetical example. If two countries at given economic levels in 1950 experience no changes in their economic levels by 1960, the rates of growth of their agricultural labor forces will be mainly a direct function of the rates of growth of their total populations. Thus, by including this latter variable in the regression equations, we might increase the values of $\bar{R}^2$. In short, though the rate of growth of the total population would most likely be a redundant variable in the context of regression analysis, substantively it is the fundamental determinant of growth of all sectors of a population including that of the ALF.

In this connection, our hypothetical model for a decline in the proportion of the ALF (Chapter III, pp. 65-66) is useful. The model is based on the empirical finding that a continuous decline in the proportion of the ALF is a universal phenomenon. In Table 12 of Chapter III, the critical levels of the rates of growth of the total labor force, μ_t^1 , were computed for three hypothetical declines in the proportion of the ALF. (If the rate of growth of the total labor force is less than the critical level, an absolute decline in the ALF occurs.) If the rate of growth of the TLF is less than 1.67 percent per year, for example, and the proportion ALF declines from .35 to .30 in a ten-year

Table 33

REGRESSION EQUATIONS, WITH THE GROWTH OF AGRICULTURAL
LABOR FORCE AS THE DEPENDENT VARIABLE, WHICH "MAXIMIZE" THE VALUES OF R^2

Region	Number of Countries	Form	R^2	Constant Term	Independent Variables			
					x_1	x_2	x_3	x_4
All Regions	59	Linear	0.553 (18.974)	193.234 (9.232)	-9.7820 (-7.923)	-0.0676 (-0.960)	-0.1515 (-2.075)	-1.5145 (-1.211)
		Loglinear	0.562 (25.840)	5.819 (23.337)	-0.0960 (-8.701)		-0.0851 (-2.678)	-0.0212 (-1.700)
		Semilog	0.566 (26.179)	216.790 (9.130)	-9.2017 (-8.758)		-8.3899 (-2.773)	-1.8536 (-1.563)
		Linear	0.351 (4.418)	121.762 (5.857)	-7.6937 (-3.462)	0.2308 (1.080)	0.1568 (1.094)	
Europe	20	Loglinear	0.344 (10.943)	5.0435 (25.792)	-0.0888 (-3.308)			
		Semilog	0.373 (12.289)	137.231 (8.672)	-7.6117 (-3.506)			
		Linear	0.249 (2.287)	97.599 (2.308)	-4.0276 (-1.938)		-0.2490 (-1.600)	3.1045 (1.360)
		Loglinear	0.241 (2.802)	4.9547 (9.862)	-0.0421 (-2.102)		-0.1031 (-1.505)	0.0226 (1.065)
Frontier Countries	21	Semilog	0.224 (2.639)	130.9050 (2.404)	-4.2150 (-1.943)		-10.5868 (-1.427)	2.6837 (1.165)
		Linear	0.621 (17.372)	205.783 (10.113)	-14.9901 (-5.450)			
		Loglinear	0.549 (25.337)	5.4064 (35.269)	-0.1267 (-5.034)	-0.4387 (-1.721)		
		Semilog	0.582 (28.805)	178.7723 (13.140)	-11.9863 (-5.367)			

Note: See notes for Table 31.

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period (Case III), the ALF will decline in absolute numbers. The critical level was 1.25 percent for a decline in the proportion ALF from .45 to .40 (Case II), and 0.72 percent for a decline in the proportion ALF from .75 to .70 (Case I). Case III might be descriptive of a typical highly developed country. In such a country, the rate of growth of the TLF, and implicitly the rate of growth of the total population, is less than or quite close to 1.67 percent per year. (On the other hand, countries described by Case I and Case II would most certainly have rates of growth of the TLF higher than the critical levels.) Thus a decline in the absolute size of the ALF is inevitable in highly developed countries at the present pace of economic development because of their low rates of total population growth.

At the beginning of this chapter, we gave four reasons for the much lower rate of growth of the ALF in countries at economic level 4 than in those at levels 1, 2, and 3. Reason 3 is worth repeating here:

The demand for labor from the nonagricultural sector in the highly developed countries is likely to be greater than the supply of labor from the natural increase in urban areas.

A deficit of labor in the nonagricultural sector will be filled by workers from the agricultural sector (excluding international migration). This implies that the "terms of offer" by the non-agricultural sector are economically (and otherwise) attractive to agricultural laborers, which is usually the case. Agriculture is one of the least profitable businesses in highly developed countries, as the following U.S. data illustrate:

Occupation of Employed Head of Household	Mean Income per Household in 1967 (dollars)
Professional, technical and kindred workers	12,629
Farmers and farm managers	6,254
Managers, officials, and proprietors, excluding farm	12,970
Clerical and kindred workers	7,983
Sales workers	10,156
Craftsmen, foremen and kindred workers	9,536
Operatives and kindred workers	8,089
Service workers	6,334
Farm laborers and foremen	4,549
Laborers, excluding farm and mine	6,816
<u>All occupations</u>	<u>9,531</u>

Source: U.S. Department of Commerce, "Consumer Income: Household Income in 1967 by Selected Characteristics of the head," Current Population Reports, Series P-60, No. 57, December 17, 1968, Table 2.

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These data testify to the attractiveness that the non-agricultural sector has for the agricultural sector in an economy like that of the United States. Nonfarm laborers earn about 50 percent more than farm laborers and about 9 percent more than farmers (owners of land) and farm managers. The differentials based on median income are even more startling--the respective figures are 75 percent and 39 percent. Therefore there are proportionally more farm laborers in low income groups than non-farm laborers. The agricultural sector in other highly developed countries may not be handicapped to the same degree as in the United States, but income differentials of significant proportion do exist. The attractiveness of the nonagricultural sector is the fundamental basis of the "pull factors" model of migration of labor force from agricultural to nonagricultural sectors.

Farming is distinguished by several peculiar factors. It not only involves extremely hard manual work during much of the year, but at various stages a whole family may be called upon to work, in contrast to nonfarming occupations, where generally only the head of household needs to work. In spite of the near constant labor, agriculture is besieged by many insecurities. It is dependent on external factors, such as weather, variable rainfall, and sudden changes in price levels around harvest time, beyond the farmer's control. Such insecurities are more painful in highly developed countries because a farmer's chances of getting a secure urban job are better than in less developed countries. Crop insurance, corporate farming, contract farming, etc. are all designed to lessen the insecurity, but in spite of such developments, agriculture remains one of the least attractive occupations.

The relationship between economic factors and the growth of the agricultural labor force has been described in detail by Hugo Böker:

The interdependence between the migration from agriculture, the productivity of agricultural labor and the demand for agricultural products may be explained as follows: The number of workers required by a branch of economic activity is determined--from the purely economic standpoint--on the one hand by the average output per worker and, on the other, by the volume of the demand for the products in question. With a change in the ratio between labor productivity and demand, the number of workers would also be altered. Thus the number of workers must increase when, with an increase in demand, the return per person does not increase in proportion to the demand; on the other hand, it will decrease when, the demand remaining unchanged, the return increases or when the return increases to a greater extent than does the demand. On the contrary, the number of workers remains the same if the demand and the return alter in the same sense and in the same

degree. Supposing that the average consumption per head of the total population remains unaltered, the following situation would arise: If the rate of increase of the total population is greater than that of the average productivity of labor in the branch of production concerned, the absolute number of workers must increase relatively as well (in relation to the total gainfully occupied population). If on the other hand, the total population and the average productivity of labor increase to the same extent, the number of workers, in absolute figures, will remain the same, but there will be a decline in the relative figures. Lastly, if the average productivity of labor increases to a greater extent than does the total population, the number of workers required will decline both in absolute and relative figures. A corresponding situation will be determined if consumption per head is altered or if there is a simultaneous change in the consumption per head and in the number of population.¹³

Böker supports this analysis by using historical data on the productivity of the agricultural and nonagricultural sectors in the United States and West Germany.

We shall examine Böker's formulations by utilizing the FAO's index numbers of agricultural production. These index numbers are of total agricultural production--i.e., the sum of food and industrial crops and livestock and livestock products--for 55 countries for each year since 1952-53. From these numbers, we have estimated the index of agricultural production for each country in 1950 and 1960.¹⁴

We begin with the following notation:

P_1 and P_2 : Total agricultural production in 1950 and 1960.

p_1 and p_2 : Index numbers for total agricultural production in 1950 and 1960.

¹³"The Decline of the Population Occupied in Agriculture, Its Causes and Its Economic and Social Effects," Monthly Bulletin of Agricultural Economics and Sociology (International Review of Agriculture), Vol. XXXIII, No. 12 (December 1942), pp. 395E-396E.

¹⁴For a given country, the index number for 1960 is estimated by taking the mean of the indices for the years 1959-60, 1960-61, and 1961-62. To obtain the index number for 1950, we first fitted a straight line by the least squares method to the ten annual indices during 1952-62. Then the index in 1950 was estimated by using the least squares equation. The estimated indices for 1950 and 1960 are shown in Appendix Table III.

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A_1 and A_2 : Agricultural labor force in 1950 and 1960.

L_1 and L_2 : Arable land in 1950 and 1960.

μ_1 and μ_2 : Labor agricultural productivity in 1950 and 1960.

r_1 and r_2 : Land agricultural productivity in 1950 and 1960.

Then, by definition of average agricultural productivity, we have:

$$\mu_1 = \frac{P_1}{A_1} \qquad \mu_2 = \frac{P_2}{A_2}$$

$$r_1 = \frac{P_1}{L_1} \qquad r_2 = \frac{P_2}{L_2}$$

The percent increase in labor agricultural productivity during 1950-60, x , is:

$$x = \left(\frac{\mu_2}{\mu_1} - 1 \right) \times 100 = \left[\left(\frac{P_2/P_1}{A_2/A_1} \right) - 1 \right] \times 100$$

Since $\frac{P_2}{P_1} = \frac{P_2}{P_1}$, we get

$$x = \left[\left(\frac{P_2/P_1}{A_2/A_1} \right) - 1 \right] \times 100$$

Similarly, the percent increase in land agricultural productivity during 1950-60, y , is:

$$y = \left[\left(\frac{P_2/P_1}{L_2/L_1} \right) - 1 \right] \times 100$$

Using these relationships, we have computed the percent increase in the labor and land agricultural productivity of each country. The results are shown in Appendix Table VIII (at the end of this chapter). The summary results by economic level and main geographic region are presented in Tables 34 and 35.

In Appendix Table VIII we can see variations in the changes of labor agricultural productivity in individual countries. Here we shall briefly review some important features of these changes. The country with largest increase in labor agricultural productivity during 1950-60 was Israel--with a spectacular 225 percent (column (5), Appendix Table VIII). The U.S., Austria, and Yugoslavia registered the next highest levels of increase--between 90 and 100 percent. The countries of the European Common Market in our sample--Belgium, France, West Germany, the Netherlands, and Italy--show quite impressive gains

Table 34

PERCENT INCREASE IN LABOR AGRICULTURAL PRODUCTIVITY ACCORDING TO ECONOMIC LEVELS AND GEOGRAPHICAL REGIONS: 1950-1960						
Economic Level or Region	n	Mean (Unweighted) Percent Increase during 1950-60 of:				Total Population
		Labor Agricultural Productivity	Total Agricultural Production	ALF		
(1)	(2)	(3)	(4)	(5)		(6)
		Mean (sd)				
Economic Level 2	13	16.86(22.99)	33.16(23.46)	15.12(14.63)		28.95(5.97)
Economic Level 3	12	39.08(27.13)	49.46(32.91)	7.64(13.12)		25.98(14.19)
Economic Level 4	20	67.58(44.51)	35.57(48.20)	-19.39(15.23)		15.08(15.49)
Middle East	6	42.75(91.84)	51.77(90.27)	8.73(11.41)		32.59(18.29)
Asia	9	28.84(27.67)	40.41(15.06)	12.20(19.76)		27.84(8.38)
Frontier Countries	13	38.59(25.99)	43.16(31.45)	5.02(21.29)		31.22(8.05)
Europe	17	58.06(27.25)	27.60(20.87)	-18.74(13.63)		7.67(4.67)
<u>All Countries</u>	45	44.38(40.21)	38.58(38.34)	-1.38(20.56)		21.99(14.29)

Table 35

PERCENT INCREASE IN LAND AGRICULTURAL PRODUCTIVITY ACCORDING TO
ECONOMIC LEVELS AND GEOGRAPHICAL REGIONS: 1950-1960

Economic Level or Region	n	Mean (Unweighted) Percent Increase during 1950-60 of:			
		Land Agricultural Productivity	Total Agricultural Production	Arable Land	Total Population
(1)	(2)	(3)	(4)	(5)	(6)
Mean (sd)					
Economic Level 1	3	24.47(16.54)	29.87(13.20)	4.69(5.56)	23.25(5.41)
Economic Level 2	10	12.87(20.81)	25.80(17.23)	13.01(14.04)	28.40(5.48)
Economic Level 3	13	37.39(27.57)	46.16(35.08)	7.13(19.44)	26.60(12.56)
Economic Level 4	20	31.04(38.43)	35.57(48.20)	3.55(15.73)	15.08(15.49)
Africa	2	19.91(32.60)	48.75(5.22)	29.43(39.54)	28.92(0.65)
Middle East	6	37.31(74.98)	53.70(88.90)	12.50(14.93)	34.42(17.41)
Asia	8	19.04(11.13)	34.17(13.02)	13.14(11.03)	25.36(8.67)
Frontier Countries	14	28.89(26.81)	35.78(33.22)	6.18(18.76)	29.20(8.74)
Europe	16	30.53(17.31)	29.06(20.63)	-1.10(8.32)	7.82(4.78)
<u>All Countries</u>	46	28.46(31.72)	36.07(37.85)	6.69(16.11)	21.76(13.69)

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in labor productivity (between 68 and 80 percent). Other countries showing increases of more than 50 percent are Mexico, Brazil, Taiwan, Japan, Malaya, and Australia. Surely these gains in labor productivity are much higher than the rates of population growth.

Two countries registered a substantial decline in labor agricultural productivity during 1950-60--Morocco (-18.2 percent) and Tunisia (-14.6 percent).

It is difficult to apply Böker's theory directly using the data in Appendix Table VIII. For those countries in which the percent increase in labor productivity is significantly higher than the percent increase in total population, there is no difficulty. In almost all such countries, the rate of growth of the TLF is much less than that of the total population, the proportion of the labor force in agriculture declines substantially, and the absolute size of the ALF decreases.

Problems arise, however, when we consider those countries in which the percent increase in labor productivity is less than the percent increase in total population. Böker divides such countries into two groups--those in which productivity is positive, and those in which it is negative. In the former, he anticipates an increase in numbers in the ALF, but not in its size relative to the TLF. Algeria provides data inconsistent with this expectation; there labor productivity increased by a small amount (1.8 percent), but the size of the ALF declined by 7.68 percent. In countries with a diminishing (negative) rate of labor productivity, Böker anticipates an increase in the proportion ALF. The data for Morocco and Tunisia, in which (as we noted earlier) productivity declined by about 16 percent, are inconsistent with this expectation. In both countries, the proportion ALF declined during 1950-60 (from 61.7 to 59.1 percent in Morocco and from 61.8 to 57.8 percent in Tunisia). However, the other two countries in our sample with negative rates of productivity--East Pakistan and the Philippines--give results consistent with Böker's expectation: in both, the proportion ALF increased during 1950-60.

Other exceptions could be provided if data for other less developed countries were available. The difficulty probably arises because Böker does not give any role to international trade in agricultural products in his model. The three countries noted above as not fitting his predictions--Algeria, Morocco, and Tunisia--are rich in oil production, which enables them to import agricultural products rather than increase agricultural productivity. One solution to this difficulty may be to add agricultural imports to production figures. We cannot do this here, however, because we began with the index of production rather than the actual production figures.

To assure ourselves that Böker's formulations are mathematically correct, we can briefly present the relationships in the following manner:

To the set of notations introduced on p. 201, X_1 and X_2 --the total population in 1950 and 1960 respectively--are added. Assuming that labor force participation rates and age distributions do not change between 1950 and 1960, the proportion ALF can be expressed as A_1/X_1 and A_2/X_2 in 1950 and 1960 respectively. The actual proportion would be a constant times (A_1/X_1) . If it is assumed that the per capita demand for agricultural products does not change and that the supply of products must equal the demand in both years, we have:

$$P_1 = cX_1$$

$$P_2 = cX_2$$

where c is per capita consumption.

$$\frac{P_2}{P_1} = \frac{X_2}{X_1}$$

Böker identifies four different situations:

Case I (a): If the rate of increase of the total population is greater than that of the average productivity of labor, the absolute number of workers must increase.

In symbols, we are given that

$$\frac{X_2}{X_1} > \frac{P_2/P_1}{A_2/A_1}$$

and

$$\frac{P_2}{P_1} = \frac{X_2}{X_1},$$

then show that $\frac{A_2}{A_1} > 1$.

Case I (b): If the productivity of labor diminishes and the conditions in Case I (a) hold, then the agricultural labor force must increase in proportion to the total labor force.

Thus, we are given that

$$\frac{P_2/P_1}{A_2/A_1} < 1$$

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$$\frac{X_2}{X_1} > \frac{P_2/P_1}{A_2/A_1} \quad \text{and} \quad \frac{P_2}{P_1} = \frac{X_2}{X_1}$$

then show that $\frac{A_2/X_2}{A_1/X_1} > 1$.

Case II: If the productivity of labor and the total population increase in the same proportion, the absolute number of workers must remain the same but the proportion ALF should decline.

Thus, we are given that

$$\frac{X_2}{X_1} = \frac{P_2/P_1}{A_2/A_1} \quad \text{and} \quad \frac{P_2}{P_1} = \frac{X_2}{X_1}$$

then show that $A_2 = A_1$ and $\frac{A_2/X_2}{A_1/X_1} < 1$.

Case III: If the average productivity of labor increases in greater proportion than the population, the number of agricultural workers must decline both in absolute and relative numbers.

Thus, we are given that

$$\frac{X_2}{X_1} < \frac{P_2/P_1}{A_2/A_1} \quad \text{and} \quad \frac{P_2}{P_1} = \frac{X_2}{X_1}$$

then show that $A_2 < A_1$ and $\frac{A_2/X_2}{A_1/X_1} < 1$.

All of these relationships can be proved by using algebraic principles of inequalities. Now we can examine the results summarized in Table 34. On the basis of data from 45 countries, the increase in the average productivity of agricultural labor is twice the rate of growth of the total population. This is Case III, and we find that the ALF declined by a small amount.

The most startling result from Table 34 is probably that the increase in labor agricultural productivity in the highly developed countries (economic level 4) is four times that in the less developed countries (economic level 2). On the other hand, the rate of growth of the total population is highest in less developed countries. The differentials can be seen from the following ratios:

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	Percent Increase in <u>Labor Agricultural Productivity</u> Percent Increase of the Total Population
Economic Level 2	0.582
Economic Level 3	1.504
Economic Level 4	4.339

In view of the increase in the productivity of labor by more than four times the rate of growth of the total population in highly developed countries (Case III), a decline in the absolute size of the ALF is inevitable. Indeed, the ALF declined by an average of 17.5 percent during 1950-60.

The data for economic level 2 are consistent with Case I (a) above. For economic level 3, however, although the rate of increase in labor productivity is higher than that of the total population, the ALF shows an increase of 7.6 percent, which is inconsistent with Case III. Apparently the law of averages has not worked well here. Another explanation may be that, in order for the ALF to decline in absolute numbers, the differential of the rates of increase in labor productivity and population growth should be higher than that for economic level 3 (i.e., higher than 50 percent). However, I am unable to advance a strong theoretical justification for this explanation.

There are fewer than ten countries from the Middle East and Asia in our sample, so any conclusions concerning these regions are highly questionable. The results based on European countries support Case III. The decline in the ALF in Europe by 16.5 percent is matched by about a seven times greater increase in labor productivity than in the rate of growth of the total population.

The results in Table 34 show clearly how general economic development is related to a rise in the productivity of agricultural labor. These results provide a clear indication of the significant negative relationship between economic level and growth of the ALF. In short, with regard to the growth of the ALF, economic development is a kind of grab bag into which many things can be put and from which many things can be taken out.

The Significance of the Proportion of Arable Land to the Total Agricultural Land

We found in Table 33 that the maximizing regression equations for All Regions contain significant negative coefficients of the proportion of arable land, the variable x_3 (ARABLE/AGRI in 1960). We shall now attempt to explain the meaning of the

significant negative coefficients. The rationale of the hypothesis of a negative relationship between the growth of the ALF and the proportion of arable land (see pp. 183-184) is that a country with a low proportion of arable land (and consequently a high proportion of pasture) has a higher potential for growth of the ALF than a country with a high proportion of arable land, other things being equal. "Other things" are economic level, geographic limitations on the agricultural system, etc.

The main theme of Chapter IV was that, in the absence of economic development, a population's response to increasing population density will be to cultivate agricultural land more intensively. Converting pasture into arable farming land, as has been done in Asia, is one way to cultivate more intensively. Another way is to increase the proportion of cultivated pasture to total pasture, which has been one of the main methods employed in Western Europe. One of the most effective ways to cultivate the existing arable land more intensively is to decrease the period of fallow and use the multiple-crop system. An elaborate discussion of this point was provided in the section on fallow land in Chapter IV (pp. 112-127), where the figures on the extent of multiple-cropping in a few countries (p. 121) show its relationship to high population density. This discussion also revealed a strong relationship between the proportion of fallow land and high population densities in a few countries in Africa, Asia, and Europe. Thus we should expect a positive relationship between the proportion of fallow land and the growth of the ALF; that is, a country with a high proportion of fallow land (as many African countries have) would have a high potential for absorbing a growing ALF. If data on the proportion of fallow land were available for a sufficient number of countries, we could probably demonstrate a significant relationship between that proportion and the growth of the ALF.

The insignificant coefficients of the proportion of arable land by geographic region are not very surprising. Geographic regions are usually homogeneous with regard to agricultural practices--the proportion of arable land being one of them. Only when the proportion of arable land is related to the growth of the ALF on a comparative regional level (i.e., All Regions) do we find it to be an important explanatory variable. Most likely, we would find the same situation if the proportion of fallow land was considered in the regression equations.

The Significance of Agricultural Density: Conclusions

We found in Table 33 that agricultural density was the least important variable in the maximizing regression equations. Its absence in the regression equations for All Regions is particularly interesting. In view of the preceding discussion, it

should now be clear why agricultural density--measured by a sophisticated indicator, ALF/ARABLE--could not become an important explanatory variable when the effects of economic level and the proportion of arable land are controlled for. Our findings support the common sense argument that a population's response to high agricultural density from increasing population is to cultivate the land more intensively rather than to abandon agriculture and move to urban areas. This is also Boserup's main contention. The extreme importance of economic level further indicates that migration to the nonagricultural sector takes place only when there is sufficient demand for labor in that sector. Both results taken together mean that "pull factors" are much more important than "push factors" in the agricultural to nonagricultural migration. The usual evidence cited in support of the "push factors" model of migration is the existence of the "transfer of rural poverty" (i.e., unemployed or underemployed rural people) in cities like Calcutta and Rio de Janeiro. This may well exist, but persons involved in such movements are apparently a very small fraction of the whole ALF. The Indian case is most often cited as evidence of the large amount of unemployment in rural areas. If high density in agriculture was the main reason for outmigration from the agricultural sector, we should have found a marked decline in the proportion ALF. On the contrary, the proportion ALF changed only from 67.9 percent in 1950 to 67.3 percent in 1960. The lack of change in the relative size of the ALF can be explained, then, by insufficient economic development in India during 1950-60. Most of the newly created jobs in the nonagricultural sector were filled by the natural increase of urban areas themselves.¹⁵

¹⁵Our earlier comparison of changes in proportions of the labor force in agriculture during 1950-60 in the U.A.R. and Japan is relevant here (Chapter V, pp. 177-181, footnote 16).

Appendix Table VIII

PERCENT INCREASE IN LAND AND LABOR AGRICULTURAL PRODUCTIVITY DURING 1950-1960

Country	Percent Increase during 1950-60 in:					
	Land		Labor		Total	
	Agricultural Productivity	Arable Land	Agricultural Productivity	Labor	Agricultural Production	Agricultural Labor Force
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Algeria	-1.00	-1.00	1.80	-6.02	-7.68	20.90
Morocco	1.35	-3.89	-18.20	-2.59	19.08	29.93
Tunisia	-10.69	18.33	-14.56	5.67	23.68	16.93
U.A.R.	30.79	3.91	25.02	35.90	8.70	27.49
Ethiopia	42.96	1.47	-1.00	45.06	-1.00	29.37
South Africa	-3.14	57.38	34.99	52.44	12.93	28.46
Canada	-8.46	7.62	36.32	-1.48	-27.73	30.37
U.S.	28.02	-8.16	98.50	17.58	-40.77	19.07
Guatemala	-1.00	-1.00	42.24	70.94	20.18	36.51
Honduras	17.86	14.53	11.14	34.98	21.46	34.26
Mexico	73.21	19.51	56.64	107.01	32.16	35.41
Panama	16.66	22.32	18.24	42.71	20.69	33.66
Cuba	23.83	4.52	-1.00	29.42	-1.00	23.75
Brazil	27.14	50.36	66.31	91.18	14.95	36.54
Colombia	71.41	-24.93	14.34	28.67	12.53	40.46
Venezuela	65.62	-7.67	28.93	52.91	18.59	44.32
Argentina	34.22	-19.08	20.23	8.61	-9.67	17.20
Chile	16.84	3.38	8.19	20.79	11.65	27.98
Uruguay	-19.53	1.07	-1.00	-18.67	-1.00	15.64
Taiwan	34.65	18.81	52.77	59.98	4.71	39.28
Japan	18.74	15.57	72.67	37.23	-20.53	11.99
Burma	11.08	11.11	-1.00	23.42	-1.00	19.13

Appendix Table VIII (continued)

(1)	(2)	(3)	(4)	(5)	(6)	(7)
Malaya	-1.00	-1.00	64.19	51.26	-7.88	33.12
Philippines	2.70	36.51	-0.40	40.19	40.75	33.60
Thailand	-1.00	-1.00	23.04	62.47	32.04	33.73
Iraq	-22.98	37.07	-1.00	5.57	-1.00	31.87
Israel	181.50	17.51	224.85	230.80	1.83	68.04
Turkey	43.89	2.06	37.58	46.86	6.74	32.26
Ceylon	21.43	8.75	25.28	32.05	5.41	28.89
India	33.73	3.37	8.61	38.24	27.28	21.64
Pakistan, East	19.38	1.48	-0.05	21.14	21.20	21.24
Pakistan, West	10.63	9.50	13.41	21.14	6.82	27.09
Denmark	23.40	2.47	45.26	26.45	-12.95	7.10
Finland	25.84	9.17	61.67	37.37	-15.03	10.32
Ireland	24.86	-5.89	48.01	17.51	-20.61	-4.55
Norway	-0.51	4.64	32.52	4.11	-21.44	9.52
Sweden	8.96	-8.31	44.49	-0.10	-30.86	6.43
United Kingdom	50.24	-12.30	55.79	31.76	-15.43	3.84
Austria	48.29	-7.20	98.72	37.62	-30.75	1.63
Belgium	34.21	-12.58	72.19	17.33	-31.86	5.95
France	25.19	1.58	67.71	27.16	-24.18	9.46
Germany, Federal Republic	21.81	0.10	68.28	21.93	-27.54	9.16
Netherlands	35.26	-4.17	65.46	29.63	-21.66	13.33
Switzerland	26.68	-10.43	43.67	13.47	-21.02	15.14
Greece	33.43	17.52	52.79	56.81	2.63	10.23
Italy	22.26	0.90	79.88	23.36	-31.42	6.14
Portugal	-1.00	-1.00	5.88	4.20	-1.59	5.31
Spain	33.14	0.32	51.08	33.56	-11.60	8.77
Yugoslavia	75.47	6.61	93.57	87.08	-3.35	12.58
Australia	26.87	14.06	47.35	44.71	-1.80	25.81
New Zealand	30.71	9.05	53.28	42.54	-7.01	24.32

Chapter VII

CONCLUSIONS

Our research has involved a great amount of empirical information and data processing and, because of the worldwide coverage, many problems of comparability have arisen. In each chapter substantive and methodological questions have been posed that are difficult to summarize briefly. Here I shall attempt to review the findings without obscuring the discussion with frequent citations from earlier chapters, references to particular methodological problems, or elaboration upon exceptional cases.

It will be recalled that we divided the 156 countries of the world having total areas of 5,000 square kilometers or more into four economic groups (levels 1-4, 1 being the lowest level and 4 the highest), five geographical regions at the continent level, and 22 geographical subregions. These classifications became basic elements of our analysis. The analysis rests on the collection and processing (for as many of the 156 countries as possible) of the following types of basic data: agricultural labor force (males); total labor force (males); farm population; rural population; total population; agricultural land areas for the land-use categories of cultivated land, fallow land, arable land, and cultivated and natural pastures; total electricity production; and indices of total agricultural production. Data concerning each were sought for both 1950 and 1960.

We found that 80-90 percent of the population is rural in the less developed countries (economic levels 1 and 2), whereas only 41 percent is rural in the highly developed countries (economic level 4) in 1960. This variation between economic levels and the general decline in rural proportion during 1950-60 confirms the widely held belief that the proportion of rural population is negatively associated with economic development. However, the negative relationship is not very strong: the coefficient of variation for the rural proportion in economic level 4 is much higher than it is in the other economic levels. In the economic level 4 group, one can find countries such as South Africa, Japan, Austria, Poland, and New Zealand, where the proportion RURAL is between 40 and 50 percent, along with countries such as Israel, the U.K., and Germany, where the proportion RURAL is as low as 20 percent. This indicates that urbanization is not a necessary condition for economic development. When economic development occurs, the structure of the rural population changes; the population dependent on agriculture (i.e., the farm population) declines,

and the nonfarm population increases. These opposing forces tend to keep the rural population at a constant level, or declining at a much slower rate than the rate at which the agricultural labor force and farm population are reducing. Thus, the extent of urbanization is not a reliable indicator of the stage of economic development.

On the other hand, changes in the male agricultural labor force (ALF) are very consistently parallel with stages of economic growth. The reduction in the proportion of the ALF to the total labor force (TLF) as the level of economic development rises is one of the most consistent trends in demographic history. The average proportion ALF in different economic levels varies tremendously: the percentages of labor force in agriculture in 1960 are 76.0, 65.0, 48.5, and 21.0 in economic levels 1 to 4 respectively, and the higher the economic level, the greater the reduction in the proportion ALF during 1950-60. On the basis of matched countries, there was a decline of about 30 percent during 1950-60 in the proportion ALF in economic level 4, whereas the comparable reduction in economic levels 2 and 3 was less than 10 percent. It is interesting that the largest reduction in the proportion ALF occurs when the initial level is between 40 and 50 percent; it can decline by as much as one percentage point per year. The decline in the proportion ALF is more or less a universal phenomenon: we estimated that the average percent of the labor force in agriculture in the world declined from 54.8 in 1950 to 51.9 in 1960. (We shall discuss the reasons for this decline in the proportion ALF below.)

We found that the concept of farm population--i.e., the population that derives its livelihood from agriculture--is very useful in the study of rural population. The relative magnitude of the farm population was studied by using the proportion of farm population within the rural population (FARM/RURAL). In countries at economic levels 1, 2, and 3, more than three-fourths of the rural population is farm population. On the other hand, in highly developed countries the average level is 56.0 percent in 1960, and these countries showed the greatest decline during 1950-60. This suggests that the conditions in highly developed countries are conducive to a sharp reduction in the proportional size of the farm population. Indeed, when we examined the data at the subregional level, we concluded that the FARM/RURAL ratio is an inverse function of the extent of mechanized farming. In the United States, the proportion FARM/RURAL declined from 42.1 to 24.7 percent during 1950-60, and its level in 1960 is one of the lowest in the world. The data for Northern and Western Europe and Australia-New Zealand substantiate the hypothesis that the FARM/RURAL ratio is negatively associated with the level of mechanized farming and industrial inputs in agriculture. In advanced farming systems, there is a great demand for servicing personnel (who must live in rural areas) to cater to the needs

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of a highly advanced agriculture. At the same time, the productivity of agricultural labor is raised dramatically, thereby reducing the size of the farm population. The combined effect of these opposing forces is a very low FARM/RURAL ratio (and also its drastic decline with the passage of time). In addition, since highly advanced farming systems exist only in highly urbanized societies, there emerges a large segment in the rural population that caters to the tourist industry of rural character. An extremely low FARM/RURAL ratio, such as less than 20 percent, is not an indicator of advanced agricultural technology. Rather, it indicates the general demise of the agricultural sector; the U.K. and Sweden are the important examples.

We argued that the concept of farm population seems to be meaningless in less developed societies, since the bulk of the rural population in these societies is engaged in agricultural activities of one form or another. This is probably why such countries do not give high priority to tabulating farm population in their censuses.

We studied the relationship between the size of the rural population and the agricultural labor force by using the ratio RURAL/ALF--the number of rural persons per male agriculture worker. The ratio fluctuates between 4.2 and 4.6 in 1960 in economic levels 1-3, but in economic level 4 it is substantially higher--7.6 in 1960. Its magnitude in 1960 in the U.S. and Belgium, for example--14.1 and 13.7 respectively--is far greater than in most other countries. In addition, the increase in the ratio during 1950-60 was largest (from 6.0 to 7.6) in the group of highly developed countries. These results indicate that conditions prevailing in highly developed countries raise the ratio drastically from its normal value of about 4.0-4.5--a conclusion consistent with the results based on FARM/RURAL ratios (i.e., the FARM/RURAL ratio is substantially lower in economic level 4 than in the other levels), since the major factor affecting RURAL/ALF is the proportion of the farm population within the rural population.

In studying RURAL/ALF ratios, we stressed the basic conceptual difference between the rural population and the agricultural labor force. The rural population in a country is distinguished from the urban population on the basis of certain criteria that make everyone fall into one of the two categories. There is no such dichotomy with respect to a person's occupation; occupation is a personal characteristic while "rural/urban" is a community characteristic. This is why the rural population may not be comparable between countries when the ALF would be. Therefore, among other things, a definition of rural population based on socio-economic concepts must be tied to the level of the ALF in a community; this leads to a method of evaluating the size of the rural population on the basis of the observed RURAL/ALF ratio.

We presented a hypothetical model showing that under the condition of no migration (and some other less important conditions), the RURAL/ALF ratio would be between 3.5-3.8--in the realm of common demographic possibilities. A value lower than this would mean an underestimation of the rural population, and a higher value an overestimation and/or the outmigration of the ALF, an increase in the proportional size of the nonfarm population in rural areas, etc. The empirical investigation of basic ratios led to the conclusion that, with very few exceptions, whenever the ratio RURAL/ALF is less than 4.0, the proportion RURAL is less than the proportion ALF. Later this conclusion was modified and the general rule stated that "if the proportion RURAL is less than the proportion ALF, the size of the rural population is very likely underestimated." This rule is consistent with (or follows from) the realization that if the rural population is defined according to socio-economic concepts, every rural population includes a nonfarm population. On the basis of these arguments we found 12 countries, the majority in South America and Southern Europe, that (based on their national definitions) have underestimated rural populations. Among these are six large countries belonging to economic level 3 that contain about three-fourths of the total ALF among the 19 "sample" countries at economic level 3. We concluded that, due to the substantial size of these countries, our general results involving population were erratic for economic level 3.

We then briefly reviewed the results on agricultural land-utilization and population/agricultural densities. A problem arose regarding the order of presentation of these topics. On the one hand, we wanted to incorporate densities in the discussion of land-utilization. On the other hand, the discussion of densities could not be fully appreciated without a prior treatment of agricultural land. We decided to follow the order of presentation of the relevant chapters--that is, discuss land-utilization first and then densities, but use densities in the discussion of land-utilization when necessary.

Our earlier discussion of the agricultural population was based on the differentiation of countries by economic levels. However, with regard to agricultural land, the geographic locations of countries are more important than their economic levels. Therefore the main discussion relates to geographic regions, although the results by economic level are presented in Chapter IV. In describing land-utilization, we defined agricultural land as consisting of two main parts: arable land and pasture. Arable land is subcategorized, wherever possible, into cultivated land and fallow land; the former consists of cultivated areas under both temporary crops and permanent crops, as well as temporary pasture and meadows. Pasture areas are subcategorized, wherever possible, into cultivated pasture and natural pasture.

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On the average, in 1960, more than one-third of the total land in Africa, Asia, and the Frontier Countries (the Americas, Australia-New Zealand, and the U.S.S.R.) is devoted to agricultural production (i.e., agricultural land), whereas only 10 percent of the land in the Middle East is used for agricultural purposes. This is, of course, due mainly to the prevalence of vast arid lands in the Middle East region. On the other hand, about 50 percent of the land in Europe is devoted to agricultural production. When we consider arable land, however, the relative distribution changes considerably. The extent of arable land in Africa and Frontier Countries differs substantially from that in Asia because of the prevalence of pasture in the former regions. In Asia, about 19 percent of the total land is arable in 1960, compared to less than 10 percent in Africa, the Middle East, and the Frontier Countries. Once again, Europe leads the other regions, with 30 percent of the total land classified as arable.

There are considerable variations in the proportions of agricultural land and arable land at the subregional level. The Northern African region has the lowest proportion of agricultural land among all the subregions--5.8 percent of the total land in 1960. The Western and Middle and Southern African regions show a level of 27 percent in 1960, while the Eastern Africa subregion displays a much higher level of land-utilization: 40.1 percent. In the Americas, about 40 percent of the land is devoted to agricultural production in the Northern American, Middle American, Caribbean, and Temperate South American regions. In the Tropical South American region, the proportion is a low 16.8 percent. The Caribbean region leads the other American regions in the extent of arable land.

In Asia, there is very little pasture in the sense of the American and European grasslands; perhaps because of this, the coverage of data on pasture is very poor in Asia. Thus, by and large, data on arable land and agricultural land are the same in Asia. In East Asia, a region well-known for its high population density, only 12 percent of the total land is arable--mainly because of the low level in China. The Southeast Asian region is similar to the East Asian region in the extent of arable land. On the other hand, on the Indian subcontinent (South Central Asia), 24 percent of the total land is arable. The Northern European region is very heterogeneous with regard to the extent of agricultural land, with two extremes--Denmark, with the highest proportion of arable land (64 percent) among all the countries in 1960 in our study, and the U.K., with the highest proportion of agricultural land (81.4 percent) in 1960. In the other three European subregions, about 60 percent of the total land is classified as "agricultural." The extent of arable land in these three regions approaches that in South Central Asia. Both New Zealand and Australia have very high proportions of agricultural land (50 and 60 percent respectively in 1960), but only about

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2 percent of the total land is arable, indicating the extreme dominance of pasture.

After some adjustments, we estimated that the proportion of arable to total land for the world as a whole increased from 9.62 percent in 1950 to 10.52 percent in 1960.

The proportion of arable land that is left idle to regain and retain the fertility of the soil--i.e., fallow land--is a good indicator of the type of cultivation system and the intensity of land-use. A very high proportion of fallow land would imply a forest-fallow or bush-fallow system of cultivation, and a low proportion (e.g., less than 10-15 percent) would indicate a short-fallow and annual cropping system. When the productivity of arable land is high and the supply of land abundant, there is no need to cultivate land very intensively--that is, to have a short-fallow system. Thus in countries like the United States and Canada we find a moderately high level of fallow land (about 20-30 percent).

Ester Boserup has argued that population growth is a major determinant of technological change in agriculture. A gradual increase in population forces a community to use land more extensively and intensively; as population pressure increases, and so also the demand for agricultural products, a community gradually switches from a long-fallow to a short-fallow system of cultivation. In other words, as long as modern industrial inputs do not play a major role in the agricultural sector, we should find a strong negative relationship between the proportion of fallow land and population density.

In spite of numerous problems regarding the comparability of data on fallow land between regions, the research reported in Chapter IV confirms this hypothesis. For instance, the extremely high RURAL/ARABLE densities prevailing in Kenya and Lesotho are associated with less than 10 percent of arable land as fallow. On the other hand, according to the available data, the low RURAL/ARABLE densities in other African countries are associated with more than 60 percent of arable land as fallow in 1960, indicating bush-fallow and forest-fallow systems. In the Middle East, the extremely densely populated U.A.R. has practically no fallow land. Not only has it eliminated fallow land, but the intensity of multiple-cropping in the Nile Valley is the highest in the world--75 percent of the arable land in 1960 was cultivated more than once. On the other hand, about 40 percent of the arable land was fallow in 1960 for the Middle East as a whole. Of the four European regions, all except Southern Europe left less than 3 percent of their arable land idle annually; the countries in those regions are very densely populated. Data are lacking for the Caribbean region; however, we would expect a low proportion of fallow land. The definitions of fallow land differ widely among the Latin

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American countries; however, the average level is about 30-35 percent of arable land. Needless to say, fallow land is negligible in East Asia, Japan, Southeast Asia, and East Pakistan. This does not mean, however, that long-fallow systems are not used in eastern Asia; for example, the shifting and bush-fallow systems can be found in some outlying areas of Malaya, Indonesia, and the Philippines and in the central parts of India. In contrast to eastern Asian regions, India and West Pakistan have a moderate level of population density and fallow land, but the most interesting example is provided by the U.S.S.R. Due to a vigorous anti-fallow program initiated in 1961 (the proportion of fallow land declined from 11.7 to 5.4 percent from 1961 to 1963), agricultural production increased dramatically during 1961-63. But production slumped in the following two years because of earlier interference with the natural process of regaining soil fertility.

On the whole, there has been a slight decline in the proportion of fallow land among our sample of 34 countries--from 23.82 to 22.02 percent during 1950-60.

The general theory advanced regarding population growth and technological changes in agriculture is also applicable to pasture areas. The basic principle is that more agricultural land is required to supply food for a non-vegetarian population than for a vegetarian population of equal size. Consequently, as long as industrial inputs are negligible in an agricultural system, a society faced with continuous population growth would gradually convert pasture, particularly cultivated pasture, into arable land. This change would be in addition to (or coincident with) the intensive cultivation of arable land. This does not mean that livestock would eventually be eliminated; livestock are the major source of draft power, milk-products, and traditional fertilizers. On the contrary, there is a growing need for livestock, which creates another important force acting on pasture--particularly cultivated pasture.

In industrial societies, a high level of demand exists for better quality food, which means, among other things, that the diet is dominated by meat products. This demand, coupled with the high productivity of arable land, increases the extent of cultivated pasture at the expense of arable land and/or natural pasture. Pastoral farming becomes very profitable in highly developed countries. The general argument presented here applies very well to Western Europe and other highly developed countries. In Northern, Western, and Eastern Europe, about 40-50 percent of pasture is cultivated, and there was very little change during 1950-60. Thus in these European regions we observe a system of agricultural land-use with intensive arable and pastoral farming. (In Chapter IV we provided a historical account of the different forces acting on land-use in Europe which led to the emergence of this system.)

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The virtual absence of pastoral farming in Asia supports the argument that high population density, in the absence of significant economic development, forces a society to give top priority to arable farming. In such a farming system, non-vegetarian food components are derived from outside agricultural land--that is, from lakes and oceans. In dense regions like the East Asian countries, East Pakistan, West Bengal in India, and Ceylon, rice becomes an ideal staple food because of its exceptional ability to grow under a variety of climatic and soil conditions, its nutritional content, and its high yield per acre.

We come now to the focal point of this study--the discussion of population/agricultural densities. After reviewing the different measures of agricultural population and agricultural land for their coverage, quality, and comparability, we found that the two measures of density--RURAL/ARABLE and ALF/ARABLE--would most adequately indicate the comparative world situation. In addition, we provided comparative densities for those regions where pastoral farming is important by adding cultivated pasture to arable land. (This sum is called CULTIVATED land, or arable land in a broader sense.)

In order to obtain the group averages, we did not compute the unweighted averages of densities. The following chart illustrates why and how the unweighted averages distort the comparative picture.

ALF/ARABLE Density: 1960

<u>Group</u>	<u>Number of Countries</u>	<u>Unweighted Density</u>	<u>Weighted Density with Weights:</u>	
			<u>ALF</u>	<u>ARABLE</u>
Economic Level 1	10	49.89	115.36	62.06
Economic Level 2	30	43.99	52.17	42.80
Economic Level 3	19	34.40	32.69	25.38
Economic Level 4	25	24.27	27.00	9.12

The unweighted densities do not take into account the relative sizes of the ALF and arable land in individual countries; they give equal weights to individual densities, by definition. On the other hand, when the weights--whether the size of the ALF or arable land--are applied, the comparative levels of countries by economic status change dramatically. When the ALF are used as weights, the average ALF/ARABLE density in economic level 4 is about one-fourth of that in economic level 1, whereas it is about one-half when unweighted densities are used. For these reasons, we have not shown unweighted densities, and our analysis is based entirely on weighted densities.

Two types of average densities are computed--one by weighting with the numerator characteristic (i.e., the population characteristic) and the other by weighting with the denominator

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characteristic (i.e., the land characteristic). We labelled these weighted averages, in the case of RURAL/ARABLE density for instance, the population RURAL/ARABLE density and the land RURAL/ARABLE density respectively. As an illustration, we obtained population and land crude densities (TOT POP/TOT AREA) for the 49 countries at economic level 1 in 1960 of 86.27 and 17.50 respectively. A substantive interpretation might be as follows: The population crude density means that a person selected randomly from the 49 countries at economic level 1 (i.e., from among 377,064,000 persons) would find himself surrounded by 86 persons on a square kilometer of land, whereas the land crude density means that 17.5 persons would be found in a square kilometer of land selected randomly from the total land area of the 49 countries.

We turn now to a discussion of levels of crude densities and other population/agricultural densities.

SELECTED DENSITIES BY ECONOMIC LEVELS: 1960

<u>Weighted Densities with Numerator as Weights</u>		
<u>Economic Level</u>	<u>TOT POP TOT AREA</u>	<u>RURAL ARABLE</u>
1	86.27	395.11
2	84.09	357.55
3	42.42	130.57
4	95.21	194.95

As is evident from the chart, the level of population crude densities in 1960 (i.e., the densities weighted by population characteristics) in economic levels 1, 2, and 4 are quite similar, ranging between 84 and 95. But the level in economic level 3 is half of that in the other economic levels. When we consider RURAL/ARABLE densities, the picture is quite different. The average RURAL/ARABLE densities weighted by the rural populations of the individual countries are between 350-400 in economic levels 1 and 2 in 1960. On the other hand, the corresponding weighted averages in levels 3 and 4 are much lower--130.6 and 194.95 respectively.

When we use arable land weights, the magnitudes and variations of densities are not the same as when we use population weights. The average RURAL/ARABLE densities weighted by the arable land of the individual countries in economic levels 1 and 2 are about the same--235.2 and 250.2 respectively. The corresponding averages in economic levels 3 and 4 are not only much less than the averages in levels 1 and 2, but they are also very different from each other--i.e., the land weighted averages for economic levels 3 and 4 are 103.4 and 65.7 respectively. In other words, a typical piece of arable land in a less developed country

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(economic level 1 or 2) supports five times more rural persons than in a highly developed country. This does not mean, however, that all highly developed countries have an abundance of arable land. In fact, the coefficient of variation of RURAL/ARABLE density in economic level 4 is about two-and-one-half times more than that in economic levels 1, 2, and 3. We have identified three main groups of countries among highly developed countries on the basis of the level of agricultural densities. The first group consists of Japan, which has a high labor-intensive agricultural system, with a RURAL/ARABLE density of 794--the second highest in the world. The second group contains most of the European countries, excluding a few East European countries, with an average density of around 150 rural persons per square kilometer of arable land. The third group consists of the so-called "New World" countries with highly mechanized agricultural systems--Canada, the U.S., Australia, South Africa, and the U.S.S.R.--with densities ranging from 15 to 75.

The changes in RURAL/ARABLE densities during 1950-60 were studied only in those countries that have the necessary data for both 1950 and 1960. This restriction resulted in a smaller size sample than the one used to compute densities for 1960 alone. For instance, there are only 13 countries at economic level 1 for which we could compute the trend of RURAL/ARABLE densities during 1950-60, whereas we could compute the RURAL/ARABLE densities in 1960 alone for 30 countries in economic level 1. In general, the higher the economic level, the less the decrease in sample size. The following figures show the trend of RURAL/ARABLE density during 1950-60:

Economic Level	Number of Countries	RURAL/ARABLE Density					
		Weighted by RURAL			Weighted by ARABLE		
		1950	1960	Percent Change	1950	1960	Percent Change
1	13	285.20	329.69	15.6%	186.03	228.84	23.0%
2	27	361.07	356.62	-1.2	241.98	259.07	7.1
3	21	134.77	127.93	-5.1	99.64	100.42	0.8
4	26	229.29	188.60	-17.8	72.34	64.39	-11.0

Clearly the sharpest increase in the population RURAL/ARABLE density during 1950-60 occurred in economic level 1--about 15 percent. There were minor changes in levels 2 and 3, but the density in highly advanced countries (economic level 4) declined by 17.8 percent. In terms of our analysis, this is the crucial difference between the highly developed and the less developed countries. Not only is the initial level of density (i.e., in 1950) lower in highly developed countries, but it declines at a

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faster rate. Thus the disparity between rich and poor countries is increasing with respect to the pressure on arable land. Later, when we review the results based on ALF/ARABLE densities (which are a better measure of agricultural population density than RURAL/ARABLE densities), we will find that the disparity between rich and poor countries is even greater than that shown by RURAL/ARABLE densities.

This, then, is the gist of the comparative picture of agricultural densities in the world based on RURAL/ARABLE measures. However, as we noted in Chapter IV, there are several problems involved in the use of RURAL/ARABLE density as a comparative measure of population/agricultural density. Therefore we shall now turn to the results based on ALF/ARABLE density.

Average ALF/ARABLE densities, whether the weights are ALF or arable land, consistently decline from economic levels 2 to 4. (Economic level 1 was disregarded because of poor coverage of data, particularly on the ALF.) The population ALF/ARABLE density in 1960 in economic level 4 (27.0) is half of that in level 2 and about 18 percent less than that in level 3. The differences in the densities based on the land weighted average (i.e., when arable land is used as the weight) are even more startling. The land ALF/ARABLE density in economic level 4 (9.12 in 1960) is one-fifth that in level 2 and one-third of that in level 3. Clearly this consistency of results is achieved by eliminating the nonfarm component of the rural population; however, these results are still not strictly comparable because pasture is an important part of agricultural land in several regions. As we noted earlier, one way to improve the comparability of these densities is to add cultivated pasture to arable land (thus getting the ALF/CULTIVATED density). However, we could not simply add the cultivated pasture of individual countries, because the data for arable land are better than for cultivated pasture. We included cultivated pasture by an indirect procedure, utilizing weighted averages of different measures of land utilization and the following identity:

$$\frac{\text{ALF}}{\text{CULTIVATED}} = \frac{\text{ALF}}{\text{ARABLE}} \times \frac{1}{1 + \frac{\text{CULT PAST}}{\text{PAST}} \left[\frac{\text{AGRI}}{\text{ARABLE}} - 1 \right]}$$

The comparative levels of ALF/CULTIVATED densities in 1960 are as follows:

<u>ALF/CULTIVATED Density</u>			
	<u>Number of Countries</u>	<u>ALF as Weight</u>	<u>CULTIVATED as Weight</u>
Economic Level 2	15	50.41	41.31
Economic Level 3	14	24.21	18.80
Economic Level 4	24	22.50	7.60

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When cultivated pasture is thus added to arable land, the greatest reduction in density from ALF/ARABLE to ALF/CULTIVATED occurs in economic level 3--35.0 percent. The corresponding reductions are 20.0 percent in economic level 4 and only 3.5 percent in level 2. Therefore we concluded that ALF/CULTIVATED densities portray more accurately the comparative picture of population/agriculture densities than the other measures in this study. The average ALF/CULTIVATED density in economic level 4 when CULTIVATED land is used as weight (7.6 in 1960) is half of that in level 3 and about one-fifth of that in level 2. These, we believe, are more realistic results than those based on RURAL/ARABLE or ALF/ARABLE densities, and are some of the most significant findings in this study. They indicate that an average worker in a less developed country works along side twice as many workers as an average worker in a highly developed country on the same amount of land. Further, an average piece of arable land in a less developed country is worked on by five times more workers than the same size piece of land in a highly developed country. These results reflect both the level of agricultural technology in highly developed countries and the great disparity between rich and poor countries.

The trend of ALF/ARABLE densities during 1950-60 is of considerable interest. On the basis of the available data, we found that the population ALF/ARABLE densities in economic level 2 increased 15.9 percent during 1950-60. This was due to a 23.9 percent weighted increase in the ALF and a small increase of 4.9 percent in arable land. The trend for economic level 4 was in the opposite direction. There the population ALF/ARABLE density declined by 26.6 percent because of a 23.7 percent decline in the ALF and a small decline in arable land. On the other hand, both the ALF and arable land increased by 8 percent during 1950-60 in economic level 3, so that no change in the land ALF/ARABLE density occurred (i.e., when the densities were weighted by the arable land of the individual countries); but when the densities were weighted by the ALF of the individual countries, the population ALF/ARABLE density declined by 9.8 percent during 1950-60 in economic level 3. These apparently strange results mean that in the few countries that account for most of the ALF in the countries at economic level 3, the ALF/ARABLE density declined during 1950-60. Brazil is the most significant example among such countries. Finally, these results indicate that (as one would expect) wherever there has been a drastic decline or rise in agricultural density, it has been due to a drastic change in the ALF rather than in arable land.

We can easily infer the variation of agricultural densities by geographic regions from the results based on economic levels. Regardless of the measure or mode of weighting used, agricultural land in the subregions of East Asia, Japan, and Southeast Asia is under the greatest pressure. To a lesser degree,

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the Caribbean, South Central Asian, and Oceania regions also have very high densities. On the other hand, the ALF/ARABLE density in the Northern American subregion is not only the lowest in 1960 (2.4 agriculture workers per square kilometer of arable land), but also declined very substantially during 1950-60--from 3.8 to 2.4. Thus the agricultural system in Northern America has become a source of envy for other regions. (With Northern America we can include Australia-New Zealand, the U.S.S.R., and Temperate South America.)

When total agricultural land is considered, the ALF/AGRI densities in Australia-New Zealand (0.3 and 0.1 in 1950 and 1960 respectively) are unsurpassed by any other region.

When FARM/ARABLE densities are considered, the weighted densities in Northern America and Australia-New Zealand are, of course, very low. The densities in the Temperate South American and Northern European regions (the population FARM/ARABLE density in 1960) are near the same low level--45.2 and 48.1 respectively. This is about 30 percent less than in Western Europe and about 90 percent less than that in Southern Europe.

However, if we use TOT POP/ARABLE as an indicator of the pressure on arable land for the supply of agricultural products, Northern and Western Europe are similar to the East Asian regions--with an average density of between 570-670. Such a comparison may be misleading because of the larger share of cultivated pasture in Europe. When cultivated pasture is added to arable land, the densities (i.e., TOT POP/CULTIVATED density) in Northern and Western Europe become 308.4 and 480.0 in 1960 respectively. These levels provide a better comparison to the East Asian level of 520-590 than do the TOT POP/ARABLE densities.

In our discussion of agricultural land, we showed the implications of population/agricultural densities for interpreting systems of land use. High and low densities have, of course, a host of other demographic, social, and economic implications. For example, high densities tend to reduce farm size, affect the land ownership system, influence the productivity of land and labor, and may alter the fertility, mortality, and migration responses of agricultural populations.

We come now to the final theme of this study--namely, the development of a theory of the growth of the agricultural labor force. We have formulated three hypotheses relating to this growth:

- (1) The higher the economic level of a country, the lower the rate of growth of the agricultural labor force. This hypothesis follows from our discussion of the variation in the size of the ALF by economic levels, with the economic level of a country

being determined by the logarithm of per capita electricity production in 1960.

(2) The proportion of arable land to total agricultural land (ARABLE/AGRI) is negatively related to the growth of the agricultural labor force. This hypothesis is derived from our discussion of agricultural land (Chapter IV), where we demonstrated that, in general, the higher the agricultural density, the higher the proportion of arable land (i.e., the less the extent of pastoral farming). Since labor requirements for pasture area are less than those for arable land of the same size, a country having a low proportion of arable land has a high potential for absorbing the labor force. In other words, the additional labor through natural increase in rural areas could be absorbed in the agricultural sector by converting pasture areas into arable land. The variable used to test this hypothesis was the proportion of arable land to agricultural land (ARABLE/AGRI) in 1960.

(3) The agricultural density is negatively related to the growth of the agricultural labor force. This hypothesis is the same as the theory of the "push" factor affecting the agricultural to nonagricultural migration--that is, high densities cause out-migration of the ALF and thereby reduce the growth of the ALF. The agricultural density was represented by the ALF/ARABLE density in 1960.

We used three regression models to test our hypotheses: (1) the linear model, (2) the loglinear model, where all the independent variables (economic level, agricultural density, proportion of arable land, and growth rate of agricultural population) and the dependent variable (growth of the agricultural labor force) were expressed in natural logarithms. In general, we used the 10 percent level of significance to test the regression coefficients. Each of these regression models was fitted for the following four groups of countries: (1) All Regions (59 countries), (2) Europe (20 countries), (3) Asia and Other (18 countries), and (4) Frontier Countries (21 countries).

The regression results showed that about 55 percent of the variation in the growth of the ALF among the 59 countries in All Regions is explained by the four independent variables, and the three regression models were equally efficient. Among the independent variables, economic level was highly significant, and the proportion of arable land was significant at the 5 percent level, but the agricultural density was not significant even at the 10 percent level.

Among the regions, the $\bar{R}^2$ --the corrected coefficient of multiple determination--was more than 50 percent in the group of Frontier Countries, while it was less than 30 percent in the cases of Europe and Asia. The low values of $\bar{R}^2$ in Europe and

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Asia are probably due to the smaller variations (as measured by the coefficient of variation) in the growth of the ALF there than in the Frontier Countries and All Regions. In other words, European and Asian countries are quite homogeneous with respect to their levels of growth of the ALF.

We also computed the maximizing regression equations by deleting those independent variables that had t-statistic values of less than unity. This increased the values of $\bar{R}^2$. The most dramatic change occurred in Asia where, unlike the previous case, all the three maximizing regression equations produced statistically significant values of $\bar{R}^2$. Another interesting result from the maximizing regression equations was that the variable for agricultural density was eliminated from all the equations except the linear regression equations for Europe and the Frontier Countries. This suggests that when the effects of other variables are controlled, the agricultural density has little influence on the growth of the ALF.

Furthermore, the economic level variable is highly significant in all the maximizing equations--particularly those for All Regions and Frontier Countries. And the sign of the regression coefficient for the economic level variable is negative, as we postulated. Similarly, as we hypothesized, the signs of regression coefficients for the variable of proportion of arable land are negative also (p. 226).

The fact that the economic level emerged as an important explanatory variable for the growth of the ALF is not surprising. It confirms the results arrived at in the chapter on agricultural population (Chapter III). In the substantive discussion of regression results, we showed the increase in productivity of agricultural labor during 1950-60 by economic levels. We found that the increase in labor productivity in the highly developed countries was four times more than that in the less developed countries (economic level 2), and one-and-one-half times more than that in the countries of economic level 3. This high rate of increase in the productivity of agricultural labor in the highly developed countries seems to be the basic cause of the decline in the ALF during 1950-60.

The significant negative relationship between the growth of the ALF and the proportion of arable land is consistent with our earlier findings. If we had statistics on proportion of fallow land for a sufficient number of countries, we probably would have found a similar negative relationship between the growth of the ALF and the proportion of fallow land.

The absence of the variable of agricultural density in the maximizing regression equations is an interesting and surprising

result, particularly for the group of All Regions. However, if we combine the results of the economic level and agricultural land variables, the unimportance of agricultural density can be explained. With all the results considered together, we could say that a population's response to high agricultural density from increasing population is to cultivate the land more intensively rather than to abandon agriculture and move to urban areas. This is also Boserup's main contention in her analysis of agricultural systems in the world. The extreme importance of the variable of economic level indicates that migration of the ALF to the non-agricultural sector takes place only when there is sufficient demand for labor in that sector. These findings mean that "pull factors" are more important than "push factors" in the migration from agricultural to nonagricultural areas.

A P P E N D I X

The notes in this section illustrate the sources, concepts, definitions, and methods of adjustment of basic data concerning labor force, rural and total population, agricultural land, and electricity production used in this study. (In Chapter II we provided a general discussion of the methods used for obtaining each type of data, as well as of the problems involved in using such methods; these notes supplement that discussion.) It would not be feasible in this monograph to include the notes on sources for all 156 countries in our total sample; we can provide only a representative selection.¹

Certain sources occur very frequently in these notes; to save space we have used the following abbreviations for them:

- (1) DYB--United Nations, Department of Economic and Social Affairs, Demographic Yearbook (New York).
- (2) SYB--United Nations, Department of Economic and Social Affairs, Statistical Yearbook (New York).
- (3) YLS--International Labour Office, Yearbook of Labour Statistics (Geneva).
- (4) PYB--United Nations, Food and Agricultural Organization, Production Yearbook (Rome).
- (5) 1950 WCA--Food and Agricultural Organization, Report on the 1950 World Census of Agriculture (Rome).
- (6) 1960 WCA--Food and Agricultural Organization, Report on the 1960 World Census of Agriculture (Rome).

In addition, the abbreviation ALF is used for agricultural labor force (males), TLF for total labor force (males), and E.A. for economic active (population).

¹Any selection will necessarily be arbitrary; however, careful consideration has been given to present as balanced a representation as possible of economic levels (at least two countries from each level) and geographic regions (at least one country from each major region). Several countries were chosen because they presented unusual data-gathering problems (e.g., Mexico, Taiwan, Japan, Pakistan, Greece), and one was included because of its special importance for the author (India). The inclusion of the United States seems to need no explanation. (Scholars seeking information about the sources, methods, etc. used for a particular country not included in the sample provided below can obtain such information by writing to International Population and Urban Research, University of California, Berkeley 94720.)

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The order of presentation of the notes concerning the data for each country is: labor force, farm population, rural and total population, agricultural land, and electricity production. If data about any of these aspects of population or land are not available for a particular country, that aspect is omitted from that country's notes.

The data for rural and total populations in 1950 and 1960 are taken from Kingsley Davis, World Urbanization 1950-1970: Basic Data for Cities, Countries, and Regions (Berkeley: University of California, Institute of International Studies, 1969; Population Monograph Series, No. 4), Table A (pp. 57-82). However, as noted in Chapter II (p. 26), we have revised data for a few countries on the basis of new data and/or research discussed in Chapter III. These revisions are described in the notes below where they apply.

The basic sources for the data on electricity production were the following:

- A. (1) For 1950: SYB 1954, Table 121.
(2) For 1960: SYB 1967, Table 144.
- B. For some countries, data on electricity production are not available in these sources or are available in a form unsuitable for our general requirements that electricity production should be the sum of P-type (produced for public consumption) and I-type (produced by industrial concerns for their own consumption). Therefore, we used some supplementary sources. These supplementary sources are indicated in the individual country notes where applicable.

SIERRA LEONE

Labor Force: The data for 1960 are estimated by using the results of 1963 census and the method (3) described on p. 24, Chapter II. ALF is of "occupation" type.

1963: YLS 1967, Table 2B.

Farm Population: The population in 1960 is interpolated by using the farm population from 1950 census of agriculture and FAO's 1965 estimate.

1950: 1950 WCA

1965: PYB 1967, Table 5.

Agricultural Land: Arable land in 1960 is interpolated by using the arable land from the 1950 census of agriculture and 1964 estimate of arable land. Fallow land in 1960 is obtained

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by applying the 1964 proportion of fallow to arable land to the estimated arable land in 1960.

1950: 1950 WCA

1964: PYB 1965, Table 1.

UNITED STATES

Labor Force: The data for 1950 include figures for Hawaii and Alaska. ALF is of "occupation" type.

1950: DYB 1956, Table 13.

1960: DYB 1964, Table 10.

Farm Population: The data are derived from population censuses of 1950 and 1960. In the household schedule of 1960 population census, farm population is defined as "places of 10 or more acres in rural territories from which sales of farm products amounted to \$50 or more in 1959 or on places of less than 10 acres from which sales of farm products amounted to \$250 or more in 1959." This is the same definition as in 1959 census of agriculture. However, the definition in 1950 was less restrictive. Farm residence was determined in response to the question, "Is this house on a farm (or ranch)?" The net effect of changes in definitions is probably not significant.

1950 and 1960: Bureau of the Census, Census of Population, 1960, Characteristics of the Population, United States Summary, Vol. 1, Part 1, p. xxxviii and Table 158.

Agricultural Land: Detailed definitions of various land categories are given in the census report. Arable land (farm land) is divided by the census into three categories--viz., (1) cropland harvested, (2) cropland pastured, and (3) cropland not harvested and not pastured. The comparable areas for the three categories are available in 1949 and 1959. The third category includes cultivated summer fallow, cropland used only for soil-improvement crops, land on which crops failed, land planted to crops for harvest after the year covered by the census, and idle cropland. The estimate of the areas under summer fallow, soil-improvement crops, and idle land from the third category would be the estimate of fallow land based on our general concept of fallow land. The rest of the area of this category is land under cultivation in one form or another; therefore, it should be added to the first category--i.e., cropland harvested. The data on summer fallow land are available for 1949 and 1959, but the area under soil-improvement crops is available for 1959 census only. The areas under "idle land" are not available in either of the two censuses. However, the idle cropland was separately classified for 31 states (in remaining states, the area is stated

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to be negligible) in the 1954 census of agriculture. Thus, we can use the 1954 ratio of idle cropland to "other cropland not harvested and not pastured minus the current summer fallow" to estimate the idle cropland areas in 1949 and 1959. Similarly, the soil-improvement component in 1949 can be estimated by using the 1959 proportion. The relevant figures from the census table are reproduced below.

Item	Areas in 1000 Acres		
	1949	1954	1959
(1) Cultivated summer fallow	25,615	28,631	30,719
(2) Other cropland not harvested and not pastured	38,493	32,077	40,215
(a) Idle land	(n.a.)	(13,459)	(n.a.)
(b) Soil-improvement crops	(n.a.)	(n.a.)	(16,376)
Total: Cropland not harvested and not pastured	64,108	60,708	70,934

The ratio of idle land/item (2) in 1954 is 0.41958. Using this, item (2) can be subdivided as indicated below. Similarly, the ratio of item 2(b)/item 2 in 1959 is 0.40721. Using this, we get the following estimates:

	1949	1959
Idle land	16,151	16,874
Soil-improvement crops	15,675	16,376
Miscellaneous cultivated area (by subtraction)	6,667	6,965
Total: Item (2)	38,493	40,215

Then, the final estimates obtained are as follows:

	1949	1959
(1) <u>Cultivated land</u>	351,231	318,250
(a) Cropland harvested	(344,564)	(311,285)
(b) Miscellaneous cultivated area	(6,667)	(6,965)
(2) <u>Fallow land</u>	57,441	63,969
(a) Cultivated summer fallow	(25,615)	(30,719)
(b) Idle land	(16,151)	(16,874)
(c) Soil-improvement crops	(15,675)	(16,376)
(3) <u>Cultivated Pasture</u>	69,488	65,345
Total cultivated land (in 000 acres)	478,160	447,564
Total cultivated land (km ²)	1,935,018	1,811,202
Total cultivated land (km ²) (given in FAO, <u>1960 WCA</u>)	1,935,646	1,813,198

Thus, we have adjusted only the internal land-distribution; the total cultivated area remains unchanged. Using the figures obtained, we have interpolated and extrapolated linearly the land-utilization areas for 1950 and 1960 respectively. The census

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category of "other pasture: not cropped and not woodland" is designated as natural pasture in our classification.

1949 and 1959: Bureau of the Census, U.S. Census of Agriculture 1959, General Report, Vol. I, Table 6 and pp. 6-12.

Electricity Production: The production figure for 1950 excludes Alaska and Hawaii, and the 1960 figure excludes Alaska.

MEXICO

Labor Force: The labor force data in 1950 and 1960 censuses involve several problems. Here we shall present a brief account of proposed methods for dealing with them.

- (a) ALF is of "occupation" type. The occupation status data in 1950 are not tabulated by age, but the industry status data are, beginning with groupings 12-14, 15-19, etc. Under the implied assumptions, we estimated the agricultural labor force of "occupation" type aged 15+ years in 1950 as follows:

males in agriculture occupation aged 15+ years

$$= \frac{\text{\# males aged 15+ in agriculture industry}}{\text{\# males aged 12+ in agriculture industry}} \times \text{\# males aged}$$

$$12+ \text{ in agriculture occupation} = \frac{132,944}{144,127} \times 142,952 = 131,860$$

- (b) The occupation status data in 1960 are classified by sex but not by age. The minimum age for the E.A. population is 8 years; we want to estimate the ALF for ages 15+ years. After examining the available data on E.A. population in different tables of the 1960 source, we used the following method to obtain that estimate:

The table on E.A. population by employment status contains data by age groups 8-11, 12-14, 15-19, etc. The data can be reproduced as follows:

<u>Employment Status</u>	<u>Males 8-14 yrs.</u>	<u>Males 8+ yrs.</u>
(1) <u>Employees</u>		
(a) Manual labor	245,869	2,756,294
(b) Agricultural labor	147,434	1,924,267
(c) Other categories	11,007	1,010,729
(2) <u>Employers</u>	310	76,338

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(3) <u>Workers on own account</u>		
(a) On land given by government (<u>Ejidatario</u>)	10,357	1,138,483
(b) Farmers	28,168	1,408,972
(c) Others	7,397	873,872
(4) <u>Unpaid family workers</u>	<u>33,915</u>	<u>107,768</u>
<u>Total E.A. Population</u>	<u>484,457</u>	<u>9,296,723</u>

Clearly, items 1(b), 3(a), and 3(b) definitely relate to agriculture occupation (rather than industry). From Cuadro 26 of the source, we know that there are 5,441,070 males aged 8+ years in agriculture occupation. The sum of categories 1(b), 3(a), and 3(b) is 4,471,722 males aged 8+ years. Thus it is 82.2% of the total ALF of age 8+ years. Hence, we have obtained the age distribution of about 82% of the ALF. Assuming that the remaining 18% has the same distribution, we get

males of age 8-14 years in agriculture occupation

$$= \frac{185,959}{4,471,722} \times 5,441,070$$

where 185,959 is the sum of categories 1(b), 3(a), and 3(b). Therefore, # males aged 15+ years in agricultural occupation

$$= \frac{4,471,722 - 185,959}{4,471,722} \times 5,441,070 = 5,214,800$$

Incidentally, the percent of total E.A. males of ages 8-14 to that of 8+ years is 5.2, while the same proportion of males in the sum of categories 1(b), 3(a), and 3(b)--i.e., those definitely in agriculture--is 4.2%. Thus, our estimate of males in agriculture aged 15+ is at most in error by 1%.

- (c) The occupational distribution in 1950 is available for both sexes together, but the total E.A. aged 12+ is available by sex. Using the sex-ratio of total E.A. population aged 12+, we divide the total E.A. population aged 15+ years into males and females.
- (d) We can estimate the sex-distribution of ALF aged 15+ [as obtained in (c)] in one of the following two ways:
- (1) We can assume that the sex-ratios of total E.A. population and the ALF are the same. This assumption may not be valid, because only 56% of total E.A. population is in agriculture. The number of males in agriculture occupation would then be

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$$\frac{7,144,872}{8,272,093} \times 4,404,077 = 3,803,942$$

(2) We can assume that the sex-ratios of the ALF are the same in 1950 and 1960. The validity of this assumption, among other things, depends mainly on the similarity of concepts for defining females in the labor force. The percentages of total E.A. males in total E.A. population are 86.4 and 81.8 in 1950 and 1960 respectively. This indicates that concepts for defining females have not changed much from 1950 to 1960. Further, the proportions of the ALF of both sexes are 56.0% and 54.0% in 1950 and 1960 respectively. Therefore, as far as agriculture is concerned, the structure of the labor force has not changed during 1950-60. So finally we get

males in agriculture occupation in 1950

$$= \frac{5,214,800}{5,819,956} \times 4,404,077 = 3,946,143$$

In any case, males dominate the agricultural labor force. We have used this estimate of males in agriculture in 1950 because the assumption seems more likely to be valid than the assumption in (1). The two estimates differ by only about 4%.

1950: DYB 1956, Tables 12 and 13.

1960: Dirección General de Estadística, Departamento de Censos, VIII Censo General de Población 1960. Población Económicamente Activa, Mexico, D.F., 1964, Cuadros 26 and 27.

Agricultural Land: The land areas are derived from the 1950 and 1960 agricultural censuses.

1950: Union Panamericana, La estructura agropecuaria de las naciones americanas, analisis estadisticocensal de los resultados obtenidos bajo el programa del censo de las Americas de 1950, Washington, D.C., Table 52.

1960: Dirección General de Estadística, IV Censos Agrícola--Ganadero y Ejidal 1960, Resumen General, Mexico D.F., 1965, pp. 1 and 140.

PARAGUAY

Labor Force: The data for 1960 are interpolated by using the census results of 1950 and 1962. ALF is of "occupation" type. The minimum age of E.A. population in both censuses is 12 years. In 1950, the problem is similar to that in Mexico, and we use the same procedure to estimate labor force in agricultural occupation

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for ages 15+ years (see p. 235 above). The labor force data in 1962 are based on a 5% sample of census returns.

1950: DYB 1956, Tables 12 and 13.

1962: Dirección General de Estadística y Censos, Datos preliminares del censo de población y vivienda de 1962 obtenidos por medio de muestra, 1964, Cuadros 21 and 22.

Farm Population: Farm population in 1960 is interpolated by using the FAO's estimates of 1950 and 1965.

1950: PYB 1965, Table 5A.

1965: PYB 1967, Table 6A.

Agricultural Land: Land areas in 1950 and 1960 are extrapolated and interpolated respectively by using the estimates of 1954 and 1961. Areas under natural pasture were rejected because in PYB 1965, Table 1, a footnote states that it is largely rough grazing.

1954 and 1961: Servicio Técnico Interamericana de Cooperación, Agrícola, Manual Estadístico del Paraguay 1941-61 (data compiled by Dr. Julio Cesar of Sección Económica Agrícola), p. 4.

Electricity Production: The source for data for 1950 (i.e., the average of production during 1948-52) is United Nations, Economic Commission for Latin America, Energy in Latin America, Department of Economic and Social Affairs (E/CN.12/384/Rev. 1), Geneva, 1957.

TAIWAN

Labor Force: ALF is of "industry" type. The minimum age of E.A. population is 12 years, and no adjustments were made to get labor force for age 15+ years. The available published data have been utilized to estimate the ALF in 1950 and 1960 as follows:

The source (1) gives data for both sexes as follows:

	Labor Force at the End of the Year (in 000s)			
	1949	1950	1959	1960
Total E.A.	2,828	2,849	3,272	3,344
Agriculture industry	1,773	1,788	1,853	1,877

By taking arithmetic averages of 1949 and 1950 and 1959 and 1960, we get the respective labor force figures for the middle of years 1950 and 1960. Thus,

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	<u>Both Sexes</u>	
	<u>1950</u>	<u>1960</u>
Total E.A.	2,838	3,308
Agriculture industry	1,780	1,865

The source (2) gives data for males. We can utilize this data to compute sex-ratios:

	<u>12+ Years</u>		Ratio:
	<u>Males</u>	<u>Both Sexes</u>	
	<u>End of 1961</u>	<u>End of 1961</u>	<u>Males</u>
	<u>(Source 2)</u>	<u>(Source 1)</u>	<u>Both Sexes</u>
Total E.A.	2,694	3,429	.7856
Agriculture industry	1,367	1,912	.7150

Using these sex-ratios and the estimated labor force of both sexes, we get the male labor force (total and agriculture) for years 1950 and 1960.

- (1) Economic Research Center, Taiwan Statistical Data Book 1961, June 1962, p. 7.
- (2) The Provincial Civil Affairs Department, 1961 Taiwan Demographic Fact Book, December 1963, Table 12.

Farm Population: Farm population in 1950 is interpolated by using the 1949 estimate and 1960 agricultural census result. (The year of estimate is erroneously shown as 1950 in Appendix Table III.)

1949: C.S. Chen and C.H. Tuan, Population of Taiwan, Institute of Agricultural Geography, National Taiwan University, Taipei, 1951, p. 51.

1960: 1960 WCA, Vol. 1/a, pp. 49 and 56.

Agricultural Land: The reported arable land by the 1961 agricultural census for 1960 has been used. The arable land in 1961 is the sum of "cultivated" and "non-cultivated" land (census terminology). Cultivated land is defined as "paddy land (indicating water-containing fields regularly cultivated with paddy rice, including those shifted to planting other crops or fruit trees at the time of enumeration), upland (cultivated land not containing water due to soil conditions or insufficient water supply where only upland rice, sweet potatoes, or fruit trees can be planted), and land classified otherwise and yet utilised as paddy land or upland." The non-cultivated land is defined as "areas which are originally paddy or upland but now converted into orchards, tree nurseries or construction (farm) sites." Thus this is an area under permanent crops, and therefore a part of arable land.

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The cultivated pasture area of 35 km² in 1960 is taken from 1960 WCA report. In the census report, grassland is given only under individual households; the pasture under "public commercial holdings" is not given in the census report.

The PYB 1965 shows total pasture area of 110 km² in 1960. We presume that this is supplied by the Taiwan government and that it includes the above noted area of 35 km² of cultivated pasture. Therefore, the remaining area of 75 km² is under natural pasture and mainly in the form of public land.

Arable land in 1950 is estimated by interpolating arable land estimates of 1949 and 1951 given by FAO.

1949 (arable land): PYB 1951, Table 1.

1951 (arable land): PYB 1953, Table 1.

1960 (arable land): Committee on Census of Agriculture, General Report on the 1961 Census of Agriculture, Taiwan, Republic of China, p. 17 and Table 3.

1960 (cultivated pasture): 1960 WCA, Vol. 1/a, pp. 48 and 51.

1960 (total pasture): PYB 1965, Table 1.

JAPAN

Labor Force: Data are from the 1950 and 1960 censuses. ALF is of "occupation" type.

1950: DYB 1956, Table 13.

1960: DYB 1964, Table 10.

Farm Population: Farm populations are derived from the 1950 and 1960 agricultural censuses.

1950 and 1960: Bureau of Statistics, Statistical Yearbook 1961, p. 78.

Rural and Urban Population: The enumerated "urban" population in respective censuses is indicated below. All absolute figures in this section are in 000's.

	<u>Urban #</u>	<u>Total #</u>	<u>Percent Urban</u>
1950	31,203	83,418	37.4
1960	59,333	93,418	63.5
Percent increase 1950-60	90.1	12.0	

The increase in urban population seems too high. We shall attempt to show that the 1960 urban population is inconsistent with the farm population and very probably overestimated.

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The figures indicate that urban definitions are not comparable between 1950 and 1960. Under the Town and Village Merger Acceleration Law of 1954, many villages were merged with surrounding towns, and new townships were created by putting together adjoining villages. The following data reveal this clearly:

<u>Year</u>	<u>Cities</u>	<u>Towns</u>	<u>Villages</u>
1947	214	1811	8480
1950	248	1877	8289
1955	491	1864	2458
1960	556	1924	1031

Thus, in 1955, a large number of cities were created at the expense of villages. This seems to be responsible for the apparent huge increase in urban population during 1950-60.

<u>Census Year</u>	<u>Urban #</u>	<u>Total #</u>	<u>Percent Urban</u>
1950	31,203	83,418	37.4
1955	50,286	89,275	56.3
1960	59,333	93,418	63.5

It is obvious that the "creation of new cities" caused a drastic increase in urban population during 1950-55. Urban populations are comparable between 1955 and 1960.

Now we have to determine which of the urban population size data are consistent with other facts. The agricultural censuses give the following data on farm population:

<u>Year</u>	<u>Farm #</u>	<u>Rural #</u> <u>(Population census)</u>	<u>Farm</u> <u>Rural</u> x 100
1950	37,811	52,215	72.4
1960	34,546	34,085	101.3

Obviously the 1960 rural population is underestimated: farm population (which itself is underestimated because its source is an agriculture census) cannot be higher than the rural population in the socio-economic concept of rural/urban areas. Our analysis in Chapter III shows also that the FARM/RURAL ratio declines with economic development. A reasonable estimate of the FARM/RURAL ratio in 1960 would be 65%. This would yield a rural population of 53,148 in 1960--i.e., the proportion of rural population would be 56.9% in 1960. Then the urban population would be 40,270, showing an increase of 29% during 1950-60.

The ALF data are also correctly enumerated, as follows:

<u>Year</u>	<u>ALF</u> <u>(Males)</u>	<u>ALF</u> <u>TLF</u> x 100	<u>Rural #</u> <u>(Population census)</u>	<u>RURAL</u> <u>ALF</u>
1950	8,623	39.4	52,215	6.055
1960	6,853	25.5	53,148	7.755

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This change in the ratio of RURAL/ALF is not unusual at the level where about 30% of labor force is in agriculture (see Chapter III). Although countries such as South Korea, the Philippines, and Malaya are less developed than Japan, their RURAL/ALF ratios are similar in 1950.

	1960 (RURAL/ALF)
South Korea	5.649
Philippines	5.148
Malaya	5.631

Because of extensive and largely non-mechanized agriculture in Japan, the observed ratio of RURAL/ALF in 1960 is very likely to be higher than the true value--i.e., that which is consistent with the socio-economic concept of rural population. Another reason for expecting this is that the enumerated "rural" population shows a slight rise in size during 1950-60, whereas the ALF declined drastically during 1950-60. Thus we can find the minimum size of rural population in 1960, which is comparable in concept with 1950, by assuming no change in the ratio of RURAL/ALF. Therefore, by applying the value of 6.055 (in 1950) to the size of the ALF in 1960, we get a rural population of 41,495 in 1960--or 44.4% of the total population. This is the minimum estimate, and it is much less than the one we obtained by using farm population.

As we noted above, the 1960 ratio of RURAL/ALF is too high. Let us place it at 7.000. Then the estimated rural population would be

$$6,853 \times 7.000 = 47,971$$

and urban population would be 45,447, or 48.6% of the total population in 1960. This estimate of rural population corresponds to 72.0% farm population within the rural population (FARM/RURAL)--which is the same level as in 1950. Hence it is another minimum estimate of rural population in 1960--i.e., under the assumption that FARM/RURAL ratio does not decline during 1950-60. So we conclude that urban population most probably would not be higher than the 48.6% level in 1960. A 48.6% level of urbanization in 1960 means a growth of 45.5% in urban population during 1950-60. We have accepted this estimate of urban population.

Source: Bureau of Statistics, Statistical Yearbook 1967, Tables 9, 10, and 43.

Agricultural Land: Land areas are derived from the 1950 and 1960 agricultural censuses. However, the arable land in 1950 was modified as follows:

There is a difference in the definition of agricultural holding between 1950 and 1960. "Although the minimum area limit

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in the holding definition was the same in 1950 and 1960 (0.1 ha.), the 1950 census included holdings selling agricultural products per year for more than 10,000 yen, while in the 1960 census this limit was 20,000 yen (U.S. \$55)." We do not know the effect of this discrepancy on the coverage of two censuses. However, the area and number of holdings under .99 ha. are as follows:

	<u>1950</u>	<u>1960</u>
Area	20,013 km ²	21,844 km ²
Number	41,459	39,117

The discrepancy would most likely be in very small holdings, such as less than .99 ha. One way to make arable land comparable between 1950 and 1960 would be to assume that the area under small holdings is the same in 1950 and 1960. This assumption would increase the arable land in 1950 by 1,831 km² (= 21,844 - 20,013). We think this is not a drastic assumption; therefore, we added 1,831 to the reported arable land in 1950--i.e., 50,485. The estimated arable land in 1950 becomes 52,316 km².

1950 and 1960: 1960 WCA, pp. 77-78 and p. 94. See 1950 WCA for definition of holding in 1950.

INDIA

Labor Force: Data in 1950 and 1960 are extrapolated and interpolated by using the census results of 1951 and 1961 censuses. ALF is of "occupation" type. The census definition of E.A. population does not involve any minimum age, but the age-distribution by occupational status is available in 1961. In 1961, ALF is the sum of census categories of cultivators, agricultural laborers, and workers in mining, fishing, plantations, orchards, etc. In 1951, ALF is the sum of self-supporting and earning dependents in agricultural occupation. Under the implied assumptions, we estimated that:

$$\begin{aligned}
 & \# \text{ males in agriculture occupation aged 15+ in 1951} \\
 &= \frac{\# \text{ males in agriculture occupation aged 15+ in 1961}}{\# \text{ males in agriculture occupation of all ages in 1961}} \\
 & \times \# \text{ males in agriculture occupation of all ages in 1951} \\
 &= \frac{81,000,000}{87,814,000} \times 68,993,989 = 63,640,343
 \end{aligned}$$

Similarly, total E.A. males aged 15+ in 1951

$$= \frac{120,481,000}{129,171,000} \times 100,593,561 = 93,826,113$$

1951: Registrar General of India, Census of India 1951,

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Economic Tables of Reorganized States, Paper No. 1 of 1960, Table B-III.

1961: _____, Census of India 1961, General Economic Tables, Vol. I, Part II-B(i), pp. 86-87.

Farm Population: Farm populations in 1950 and 1960 are extrapolated and interpolated by using the results of 1951 and 1961 population censuses. In 1951, the data are given in the following form (for rural areas):

Category	# (in 000)
(1) Cultivators of land, wholly or mainly owned, and their dependents	162,923
(2) Cultivators of land, wholly or mainly unowned, and their dependents	30,213
(3) Cultivating laborers and their dependents	<u>42,941</u>
Sum = Farm population	236,077

In 1961, a 20% systematic sample was drawn from the households list. The sample was drawn at the enumeration district level (village or part of a city). The data were reported in the following manner:

Category of Household	Population in Sample Household	
	Males	Females
	(rural areas)	
(1) Neither cultivation nor household industry	7,856,876	7,743,279
(2) Only household industry	1,508,814	1,444,928
(3) In cultivation ^a	<u>26,868,093</u>	<u>25,880,041</u>
Total Rural #	36,233,783	35,068,248

The accuracy of sample tabulations can be examined as follows:

- (1) Estimated rural population from the sample of households = 356,510,155--(5 x total sample population)
- (2) Enumerated rural population, complete count = 357,922,823

Thus the sample estimate is only 0.4% less than the enumerated population. The farm population in 1961 would, then, correspond to the population in category (3) above--i.e., 52,748,134 in the

^aThis is the sum of households in cultivation only and in both cultivation and household industry.

APPENDIX: NOTES ON SOURCES OF BASIC DATA

sample. Therefore, the total farm population would be 263,740,670--i.e, 5 times sample population.

It seems that the concept of farm population was more precise in 1961 than in 1951. The observed growth during 1951-61 in farm population is 11.7% as against 20.0% in rural population. Further, the proportion of the ALF is virtually unchanged during 1951-61. Thus all this evidence indicates that the farm population, as defined by the census, is overestimated in 1951. However, we have not adjusted the farm population of 1951.

1951: _____, Census of India 1951, Paper No. 1 of 1957, pp. 176-177.

1961: _____, Census of India 1961, INDIA, Household Economic Tables, Vol. 1, part III (ii), Table B XVII.

Rural and Total Population: Data in 1950 and 1960 are extrapolated and interpolated by using the census results of 1951 and 1961. Following are the comparable figures for 1951 and 1961:

	Urban		Rural	
	1951	1961	1951	1961
India	62,443,934	78,936,603	298,644,156	360,298,168
Less Sikkim	2,744	6,848	134,981	155,341

India (excluding Sikkim
but including Jammu and
Kashmir) 62,441,190 78,929,755 298,509,175 360,142,827

1951 and 1961: Registrar General of India, Census of India 1961, INDIA, General Population Tables, Part II-A(i), pp. 54 and 64.

Agricultural Land: Land areas in 1950 are extrapolated by using the estimates through revenue records of 1951 and 1960. Although estimates for 1950 are available, concepts of land use have been revised and standardized for all of India since 1951. Therefore, we did not use 1950 estimates.

Fallow land is taken as the sum of categories of current fallow (lying fallow for less than 1 year) and other fallow land (lying fallow between 1 and 5 years). Land lying idle for more than 5 years is listed in the source as culturable waste. In accordance with our general practice, we have not included this category in fallow land.

1951 (1951-52): Central Statistical Organization, Statistical Abstract of the Indian Union, 1963 and 1964, pp. 47-49.

1960 (1960-61): _____, Statistical Abstract of the Indian Union, 1965, pp. 45-49.

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EAST AND WEST PAKISTAN

Labor Force: Data in 1950 and 1960 are extrapolated and interpolated by using the results of 1951 and 1961 censuses. The minimum age of E.A. population in 1961 is 10 years, and age-distribution by occupational status is given--beginning with ages 10-11, 12-14, 15-19, etc. Therefore, labor force for ages 15+ can easily be derived. However, the minimum age in 1951 is 12 years, and age-distribution of labor force is not available. We assumed that age-distributions are identical in 1951 and 1961. Then, for example, for East Pakistan we get

total E.A. males aged 15+ in 1951

$$= \frac{\text{total E.A. males aged 15+ in 1961}}{\text{total E.A. males aged 12+ in 1961}} \times \text{total E.A. males aged}$$

$$12+ \text{ in 1951} = \frac{13,284,860}{14,307,399} \times 11,887,080 = 11,037,519$$

Similarly, ALF for ages 15+ in 1951 were estimated for East and West Pakistan separately.

1951: Central Statistical Office, Pakistan Statistical Year Book 1962, pp. 9-10.

1961: Census Commissioner, Population Census of Pakistan 1961, Economic Characteristics, Census Bulletin No. 5, pp. xviii-xii, Statement no. 9.

Rural and Total Population: The rural and total populations of East and West Pakistan are estimated by using census results of 1951 and 1961 for the respective areas.

1951 and 1961: Census Commissioner, Census of Pakistan Population 1961, Pakistan, Vol. I, p. II-16.

Agricultural Land: There are two sources of data for arable land in Pakistan. One is the estimates compiled by the Revenue Department (equivalent to Department of Agriculture in U.S.), wherein data on cultivated area, etc., are forwarded by village officials. The second source is the agriculture census in 1960. Normally we would give first preference to census results, but we wanted to make use of revenue estimates as well. The agricultural census is based on a 10% sampling fraction (the sampling frame consists of villages as units, and complete enumeration is done in the selected villages) in East Pakistan and a 20% sampling fraction in West Pakistan. This leads to the possibility that land areas obtained through the census may be in error. We are also interested in obtaining areas for 1950. The following discussion is intended to show how and why the census and revenue estimates have been combined.

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The census definition of fallow land is (1) current fallow--"the cultivated area which was not cropped during the census year, but was cropped during the previous year," and (2) culturable waste--"the area which is fit for cultivation but which was neither cropped during the census year nor in the previous year." Therefore, it is not possible to extract land lying fallow for less than five years, for example. In accordance with our adherence to national definitions, we accepted the census category of current fallow as fallow land.

On the other hand, the revenue reports give estimates of fallow land, but their category does not include any time limit. For a country like Pakistan, we would expect the revenue fallow land area to be approximately equal to the sum of census categories of current fallow and culturable waste.

Keeping the above definitions in mind, we examine the following figures:

Areas in 1000 Acres			
EAST PAKISTAN			
	1960 Census	Revenue Records	
		1960	1950
(1) Net sown area	18,848	20,848	20,540
(2) Current fallow	290	821	1,690
(3) Culturable waste	470		
(4) Total cropped area ^a	27,881	27,429	26,250
WEST PAKISTAN			
(1) Net sown area	32,011	32,110	28,910
(2) Current fallow	5,238	8,841	8,770
(3) Culturable waste	7,093		
(4) Total cropped area ^a	38,807	34,531	31,890

Thus in West Pakistan the new sown areas are remarkably the same through the census and revenue records in 1960. But in East Pakistan the net sown area is 2 million acres more in the revenue records of 1960. One important reason may be that in East Pakistan the sampling fraction was one-half that in West Pakistan (20%). Therefore, the quality of estimates in West Pakistan is better than in East Pakistan.

We have no basis to examine the data further. Therefore, we assume that the correct cultivated area in 1960 is the average

^aThe sum of net sown area and area cropped more than once during agricultural year.

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of the census and revenue estimates in 1960. The cultivated area in 1950 is obtained by applying the 1960 ratio of

$$\frac{\text{Average of the two estimates}}{\text{Revenue estimates}}$$

to the revenue estimates in 1950. This procedure recognizes the possibility that revenue records overestimate the net areas.

In East Pakistan, the sum of current fallow and culturable waste (760) is quite close to the revenue estimate of 821 in 1960. But the situation is much different in West Pakistan. The census shows a sum of 12,231 as against the revenue estimate of 8,841. Why this is so, we don't know. In any case, we are not interested in culturable waste.

In order to estimate fallow land in 1950, we opted for different methods for East and West Pakistan.

- (1) West Pakistan: We assumed that the 1960 ratio of

$$\frac{\text{Census current fallow}}{\text{Revenue fallow area}} \text{ holds good in 1950.}$$

- (2) East Pakistan: The revenue records show that fallow area has reduced by half during 1950-60. Part of the reason may be that land is being cultivated more intensively because of increase in population. If this reasoning is correct, then we should expect a corresponding increase in net sown area. But the arable land (net area + fallow) has decreased from 22,230 in 1950 to 21,169 in 1960. Therefore, our conjecture is that the concept of fallow has changed in revenue records during 1950-60. In view of the small areas involved, we assumed that the extent of fallow land in 1950 is the same as shown by the census in 1960 (current fallow).

1960 (census): Agriculture Census Organization, Pakistan Census of Agriculture 1960, Final Report East Pakistan, Vol. I, pp. 8-9 and 108-114; and West Pakistan, Vol. II, Report 2, p. 112.

1950 and 1960 (revenue records): Central Statistical Office, Statistical Yearbook, 1964 Pakistan, pp. 93-94.

Electricity Production: For mean production around 1960, indirect estimation is required to get data for East and West Pakistan separately.

It is possible to get ratios for East and West Pakistan for the years 1950, 1960, and 1962-63 (see following table). The mean of the ratios for the three years is .8527. We can assume that this mean ratio is applicable to the period 1958-62. The source (2) gives annual production figures for All Pakistan during 1958-62. The mean production per year during 1958-62 is

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	Production in million KWH		
	1959	1960	1962-63 (April-April)
West Pakistan	1125.7	1221.2	2198.6
East Pakistan	175.8	228.7	385.0
All Pakistan	1301.6	1449.9	2583.6
Ratio: $\frac{\text{West Pakistan}}{\text{All Pakistan}}$	.8648	.8423	.8510
Source	(1)	(1)	(2)

1620.7. Using the ratio of 0.8527, we get mean production during 1958-62 in West Pakistan = 1381.9 and mean production during 1958-62 in East Pakistan = 238.8.

The source (3) gives annual productions during 1948-52 for East Pakistan and source (4) gives for All Pakistan. Then the figures for West Pakistan are obtained by subtraction.

- (1) Central Statistical Office, Electric Power Statistics 1959 and 1960, Karachi, 1962, p. 2.
- (2) _____, Census of Electricity Undertakings 1962-63, Karachi, 1965, pp. 20 and 31.
- (3) The Provincial Statistical Board, Statistical Abstract for East Pakistan, Vol. II, Dacca, 1955.
- (4) Central Statistical Office, Pakistan Statistical Yearbook 1962, p. 133.

GREECE

Labor Force: The data for 1950 and 1960 are extrapolated and interpolated respectively by using the results of 1951 and 1961 censuses. ALF in 1961 is of "occupation" type. "Industry status" data are available in 1951, but not occupational status data. Under the implied assumptions, we get

$$\begin{aligned} & \# \text{ males in agriculture occupation in 1951} \\ &= \frac{\# \text{ males in agriculture occupation in 1961}}{\# \text{ males in agriculture industry in 1961}} \\ & \times \# \text{ males in agriculture industry in 1951} \end{aligned}$$

1951: DYB 1956, Table 12.

1961: DYB 1964, Tables 8, 9, and 10.

Farm Population: The farm populations in 1950 and 1960 are extrapolated and interpolated respectively by using the

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results of 1951 and 1961 population censuses. The data in 1951 are given in the following form:

Areas	E.A. Population in Agricultural Industry		E. Inactive Population Dependent on E.A. Popu- lation in Agriculture	
	Males	Females	Males	Females
Urban	98,544	7,977	40,362	105,453
Semi-urban	190,711	37,557	107,439	270,433
Rural	826,536	168,938	552,783	1,357,928
Totals	1,115,791	214,472	700,584	1,733,814

Therefore the farm population in the rural areas is 2,906,185.
(The farm population in all areas is 3,764,661.)

The farm population in 1961 is estimated from the following data on households:

Size of Household	# of Households Whose Head is Engaged in Agriculture Occupation in Rural Areas	Size of Household	# of Rural Households
1	34,343	1	76,887
2	90,579	2	137,428
3	117,489	3	161,378
4	136,892	4	179,031
5	113,289	5	142,778
6-7	121,708	6	95,663
8-9	31,754	7	52,991
10+	7,575	8	26,153
	653,629	9	12,017
		10	5,550
		11	1,880
		12+	1,823
			893,590

The estimation of farm population requires the knowledge of mean size of household in the size-categories of 6-7, 8-9, and 10+. Since the majority of rural households are agriculture households, we can assume the identical household size distribution between the two groups, and thus utilize the detailed data on rural households. The procedure is divided into two parts.

- (1) Estimation of mean size of rural households for the size groups 6-7 and 8-9.

This is quite straightforward--by using the size-distribution of households corresponding to sizes 6, 7, 8, and 9. For example, mean size of household in the group 6-7

$$= \frac{6 \times 95,663 + 7 \times 52,991}{95,663 + 52,991} = 6.3564$$

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Similarly, the mean size of household in the size group 8-9 is 8.3148.

(2) Estimation of mean size of rural household in the size group 10+.

(a) Total population in rural households--i.e., rural population	= 3,629,883
(b) Population in rural households of size less than 10 (by using the size-distribution)	= <u>3,528,183</u>
Population in households of size 10+	= 101,700
Hence, mean size of households of size 10+	= <u>101,700</u> 9,253
	= 10.9910

Using the above mean sizes for groups 6-7, 8-9, and 10+, and the remaining size distribution of agricultural households, we get an estimated farm population in 1961 of 2,802,891.

1951: Statistique National de la Grèce, Résultats du recensement de la population effectué le 7 Avril 1951.
Tableaux des caractéristiques économiques de la population,
Vol. III, Athens, 1958, p. 3.

1961: Office National de Statistique, Résultat du recensement de la population et des habitations effectué le 19 Mars 1961. Caractéristiques démographiques, sociales et économiques du logement des "ménages," Vol. III, Athens, 1968, Table 23, p. 292.

1961 (for size distribution of rural households): National Statistical Service of Greece, Statistical Yearbook of Greece 1965, p. 32.

Agricultural Land: Land areas in 1960 are interpolated by using the 1950 estimates and results of 1961 census of agriculture. Fallow is defined as "the land, which is generally cultivated or planted, is not sowed by the autumn of 1961 or the area on which no harvest is expected during the rest of the year (1961). It also includes the area which is sowed or planted in autumn of 1961 with an expectation of harvesting in 1962." Since pasture area is not available for 1960, we substituted the 1961 pasture area for 1960. The areas are given in stremmas (1000 stremmas = 1 km²).

1950 and 1961: Office National de Statistique, Résultats du recensement de l'agriculture--et l'arage effectué le 19 Mars 1961, Vol. I, Table 1-1, pp. 30-35 (Tables V, VII, IX, and XI).

Appendix Table I

TYPE OF AGRICULTURAL AREAS: 1950 AND 1960

(Areas are in square kilometers)

Region and Country	Census or Estimate ^a	Total Area	Culti- vated Land	Arable Land	Culti- vated Pasture	Total Agricul- tural Land
Northern Africa						
Algeria	E1960	2381741	39710	69090	--	131650
Libya	C1960	1759540	11437	24311	784	36303
Morocco	E1950	445050	55323	89106	--	--
	E1960		--	85640	--	--
Spanish Sahara	--	266000	--	--	--	--
Sudan	--	2505820	--	--	--	--
Tunisia	E1950	125180	21480	38030	1000	--
	E1960		--	45000	1000	81000
U.A.R.	E1950	1001449	--	23578	--	--
	E1960		--	24500	--	--
Western Africa						
Dahomey	E1963	115762	5960	15460	--	19880
Gambia	E1950	10368	--	2668	--	4610
	E1964		--	2191	--	--
Ghana	E1950	238537	--	42732	--	--
	E1957		--	57543	--	--
Guinea	--	245860	--	--	--	--
Ivory Coast	--	322460	--	--	--	--
Liberia	E1948	111370	--	18328	--	20882
	E1957		--	19137	--	21694
Mali	E1960	1240000	--	12210	--	--
Mauritania	E1964	1085800	--	2630	--	395130
Niger	E1963	1267000	65000	150000	--	179000
Nigeria	S1950	878448	89764	207081	--	215294
	E1960		--	217950	--	--
Port. Guinea	E1961	36120	--	2630	--	--
Senegal	E1963	196190	22617	55000	--	--

^a Method for determining "Estimates" is explained in Chapter II, p. 28.

Appendix Table I (continued)

Region and Country	Census or Estimate	Total Area	Culti- vated Land	Arable Land	Culti- vated Pasture	Total Agricultural Land
Sierra Leone	E1950	71740	--	40145	--	62160
	E1964		534	37641	--	59102
Togo	E1950	56600	6000	21000	--	23000
	E1960		6700	19700	--	21700
Upper Volta	E1960	274200	--	49000	--	--
<u>Eastern Africa</u>						
Burundi	--	27834	--	--	--	--
Ethiopia	E1951	1184320	--	113034	--	702099
	E1961		--	114694	--	702109
Fr. Somali-land	--	220000	--	--	--	--
Kenya	C1960	582650	15695	16701	--	56135
Madagascar	E1952	590000	--	12387	--	382387
	E1960		--	13950	--	383950
Malawi	S1950	94486	--	27406	--	32912
	E1960		--	29267	--	35224
Mozambique	C1950	783030	--	29280	--	--
	S1959		--	35110	--	--
Rwanda	E1950	54170	--	22440	--	40480
	E1960		--	21190	--	38520
Somalia	E1960	637660	--	9570	--	--
South Rhodesia	--	389410	--	--	--	--
Tanganyika	E1960	937060	--	77755	--	165229
Uganda	E1950	243410	--	28394	--	--
	E1960		--	29189	--	--
Zambia	--	746260	--	--	--	--
<u>Middle and Southern Africa</u>						
Angola	--	1246700	--	--	--	--
Botswana	E1960	712250	--	5180	7770	409220
Cameroon	E1950	475442	17059	67039	--	155084
Central Afr Rep.	C1960	622984	6000	17000	--	--

Appendix Table I (continued)

Region and Country	Census or Estimate	Total Area	Culti- vated Land	Arable Land	Culti- vated Pasture	Total Agricul- tural Land
Chad	E1964	1284000	--	7000	--	52000
Congo- Brazzaville	--	342000	--	--	--	--
Congo, Dem Rep.	E1951	2345409	--	485440	--	508169
	E1959		--	490451	--	514981
Gabon	E1962	267000	--	1270	--	--
Lesotho	S1950	30344	2991	3827	--	--
	C1960		3223	3527	--	--
Southwest Africa	C1960	824300	--	6417	42	535474
Sp. Eq. Guinea	E1963	28050	--	2210	--	3250
Swaziland	E1950	17320	--	894	--	14587
	E1960		--	1420	--	16240
<u>South Africa</u>						
South Africa	E1950	1223410	--	76617	--	886617
	C1960		--	120582	2101	1024482
<u>Northern America</u>						
Canada	C1951	9976139	251760	340919	40489	--
	C1961		252604	366899	41471	--
Greenland	E1950	2176000	--	--	--	--
U.S.A.	C1949	9363353	1408015	1643110	279529	3629353
	C1959		1247548	1509060	262763	3678542
<u>Middle America</u>						
Br. Honduras	E1947	22965	--	304	--	375
	E1964		--	308	--	443
Costa Rica	C1950	50700	2683	3557	2505	9819
	C1963		3862	5451	3612	13998
El Salvador	C1950	21393	--	5443	1749	12512
	C1961		--	6433	1108	12556
Guatemala	C1950	108890	11124	14870	--	20745
Honduras	C1952	115200	4577	8705	--	16931
	E1960		--	9970	--	37970

Appendix Table I (continued)

Region and Country	Census or Estimate	Total Area	Culti- vated Land	Arable Land	Culti- vated Pasture	Total Agricul- tural Land
Mexico	C1950 C1960	1972550	108226 133792	199283 238169	-- --	872244 1029091
Nicaragua	E1952 C1963	130000	3919 5111	5007 7954	5508 9810	-- 24337
Panama	C1950 C1960	75650	2366 3280	4502 5507	4276 6835	10023 13688
<u>Caribbean</u>						
Bahama Is.	E1960	11400	--	130	--	140
Cuba	C1946 E1964	114520	-- --	20066 20972	-- --	-- 37425
Dominican Rep.	C1950 C1960	48734	6142 7314	8532 10674	6082 6000	17320 19343
Haiti	C1950	27750	--	3700	--	8700
Jamaica	S1954 C1961	11450	-- --	2651 2247	-- 667	4861 4202
Puerto Rico	C1950 C1960	8897	-- --	3022 2846	-- --	6146 5688
Trinidad- Tobago	E1950 E1961	5130	-- --	1254 1750	-- --	1314 1800
<u>Tropical South America</u>						
Bolivia	--	1098580	--	--	--	--
Brazil	C1950 E1960	8511960	-- --	190951 287122	149731 200633	1267282 1510475
Colombia	C1954 C1960	1138340	-- 34681	67236 50471	-- --	193813 196531
Ecuador	--	270670	--	--	--	--
Fr. Guiana	E1950 E1960	91000	-- --	30 30	-- --	530 530
Guyana	C1950	214970	--	940	--	26570
Peru	C1961	1285220	19340	36604	2369	127168
Surinam	E1950 C1960	142820	-- --	330 398	-- --	340 460
Venezuela	C1950 C1961	912050	14263 --	26999 24927	16596 26490	165234 189368

Appendix Table I (continued)

Region and Country	Census or Estimate	Total Area	Culti- vated Land	Arable Land	Culti- vated Pasture	Total Agricul- tural Land
Temperate South America						
Argentina	C1947 C1960	2776656	-- --	240635 194717	-- 79153	1308652 1377932
Chile	C1955 C1965	741767	14526 15089	30537 31569	10113 10418	137114 141362
Falkland Is.	E1950 E1960	11961	-- --	-- --	-- --	10360 10360
Paraguay	E1954 E1961	406752	2853 4845	4363 6380	7467 6424	-- --
Uruguay	C1951 C1961	186926	13550 12024	15669 15836	4593 5959	160048 160387
East Asia						
Taiwan	E1950 C1961	35960	-- --	8665 10295	-- 35	-- 10405
China	E1950 E1958	9761100	-- --	1003560 1179090	-- --	2852617 --
Korea, North	E1960	122390	--	18940	--	--
Korea, South	C1961	98430	--	18871	--	19049
Mongolia	E1950 E1960	156500	-- --	592 2655	-- --	-- --
Japan						
Japan	C1950 C1960	369660	-- --	52316 60462	-- --	59049 66794
Southeast Asia						
Burma	E1950 E1960	678033	-- --	55624 61804	-- --	-- --
Cambodia	E1961	172510	--	23530	--	--
Indonesia	C1963	1491564	--	135386	--	--
Laos	E1961	236800	--	10000	--	19000
Malaya	C1960	131290	--	17681	--	19062
Philippines	C1948 C1960	299681	40237 55830	49075 66990	4521 3770	-- --
Port. Timor	--	14925	--	--	--	--

Appendix Table I (continued)

Region and Country	Census or Estimate	Total Area	Culti- vated Land	Arable Land	Culti- vated Pasture	Total Agricul- tural Land
Sabah	C1960	76115	--	1587	--	1639
Sarawak	E1950	125206	--	33693	--	--
	E1960		--	29790	--	--
Thailand	C1963	514000	91126	97822	--	98724
Vietnam, North	--	158750	--	--	--	--
Vietnam, South	C1960	170810	--	23059	--	--
West Irian	--	412780	--	--	--	--
<u>Southwest Asia</u>						
Cyprus	E1946	9251	2240	3666	--	--
	C1960		2262	3688	--	4618
Fed. South Arabia	--	287680	--	--	--	--
Iran	S1960	1648000	66547	111889	1315	124704
Iraq	C1952	434924	26555	54502	--	56811
	C1958		41519	74706	--	75418
Israel	E1952	20700	3344	3506	--	--
	E1960		3977	4120	--	--
Jordan	C1953	97740	--	8410	--	--
	E1961		--	9956	--	10956
Kuwait	--	16000	--	--	--	--
Lebanon	E1950	10400	--	2870	--	--
	E1960		--	3260	--	--
Muscat-Oman	--	212379	--	--	--	--
Qatar	--	22014	--	--	--	--
Saudi Arabia	--	2149690	--	--	--	--
Syria	E1960	185180	34800	60140	--	125660
Trucial Oman	--	83600	--	--	--	--
Turkey	E1950	780576	--	152915	--	--
	S1963		106105	156068	850	163606
Yemen	--	195000	--	--	--	--

Appendix Table I (continued)

Region and Country	Census or Estimate	Total Area	Culti- vated Land	Arable Land	Culti- vated Pasture	Total Agricul- tural Land
<u>South Central Asia</u>						
Afghanistan	E1958	647497	--	--	--	53000
Bhutan	--	47000	--	--	--	--
Ceylon	C1948	65610	--	15555	--	--
	C1962		--	16916	--	--
India	E1951	3268090	1261001	1557285	--	1637189
	E1960		1379190	1609730	--	1749790
Nepal	E1964	140797	--	18310	--	--
Pakistan, East	E1950	142776	79135	80309	--	--
	C1960		80321	81495	--	--
Pakistan, West	E1950	803940	116811	137838	--	--
	C1960		129740	150937	--	--
Sikkim	--	71070	--	--	--	--
<u>Northern Europe</u>						
Denmark	C1950	43040	26759	26847	3760	31409
	C1960		27474	27510	2788	30941
Finland	C1950	337010	23668	24448	690	27281
	C1959		26122	26689	1324	29463
Iceland	--	103500	--	--	--	--
Ireland	C1949	70280	--	15695	30982	--
	C1960		--	14771	30552	--
Norway	C1949	323920	8104	8142	5346	15420
	C1959		8425	8520	4810	15076
Sweden	C1951	449730	35114	36778	1915	44230
	C1961		30993	33721	1647	39041
United Kingdom	C1950	244020	50512	51601	74061	194875
	C1960		44471	45252	79298	198603
<u>Western Europe</u>						
Austria	C1951	83850	17730	17902	10728	60973
	C1960		16397	16613	10285	38284
Belgium	C1950	30510	--	10304	1781	17268
	C1959		8965	9008	1925	16534
France	E1950	547026	--	212830	48520	335620
	E1960		--	216190	43720	346810

Appendix Table I (continued)

Region and Country	Census or Estimate	Total Area	Culti- vated Land	Arable Land	Culti- vated Pasture	Total Agricul- tural Land
Germany, Fed Rep.	E1950 E1960	246880	-- --	85271 85360	36 220 36520	160965 14 2410
Netherlands	C1950 C1960	33612	10520 10104	10563 10123	-- --	23734 23372
Switzerland	E1950 E1960	41288	-- --	4890 4380	-- --	21860 21650
<u>Eastern Europe</u>						
Bulgaria	E1950 E1960	110912	-- --	45635 46241	2964 2568	57214 56720
Czechoslovakia	E1950 E1960	127869	-- --	51240 51640	-- --	72190 70640
Germany, Dem Rep.	E1950 E1960	107901	52355 50581	53399 51429	8942 8947	66310 65225
Hungary	E1950 E1960	93030	57486 55756	58694 57030	-- --	73819 71410
Poland	E1950 C1960	311730	-- --	162669 162232	41626 41796	-- --
Romania	E1950 E1960	237500	95531 102585	97894 103460	16822 13866	143240 145466
<u>Southern Europe</u>						
Albania	E1950 E1960	28748	-- --	3912 4661	-- --	12068 12256
Greece	E1950 C1961	131944	23150 31329	30797 36193	-- --	-- 45351
Italy	E1950 C1961	301225	-- --	154549 155946	-- --	206021 206763
Portugal	E1957	88860	41300	42110	--	--
Spain	E1950 C1960	504748	142370 145503	193270 193880	-- 18020	-- 372690
Yugoslavia	E1950 E1960	255880	-- --	78350 83530	18600 19000	138250 149230
<u>Australia-New Zealand</u>						
Australia	C1950 C1960	7686810	79337 101279	113731 129716	73563 134714	3754226 4645763

Appendix Table I (continued)

<u>Region and Country</u>	<u>Census or Estimate</u>	<u>Total Area</u>	<u>Culti- vated Land</u>	<u>Arable Land</u>	<u>Culti- vated Pasture</u>	<u>Total Agricul- tural Land</u>
New Zealand	C1950	268685	3821	4188	72537	129978
	C1960		4057	4567	74232	132396
<u>Oceania</u>						
Fiji Is.	E1950	18272	--	1396	--	2044
	E1964		--	1505	146	2157
New Caledonia	E1950	19000	--	180	--	5180
	E1960		--	180	--	4180
New Guinea	E1953	238693	--	--	--	--
New Hebrides	E1949	14763	--	520	--	--
Papua Is.	--	222998	--	--	--	--
Solomon Is.- U.K.	E1950	29785	--	1450	--	1839
<u>U.S.S.R.</u>						
U.S.S.R.	E1950	22402200	1463000	1682450	--	--
	E1960		2030000	2273600	--	6012600

Appendix Table II

TOTAL LABOR FORCE (TLF) AND AGRICULTURAL LABOR FORCE (ALF),
MALES: 1950 AND 1960

Region and Country ^a	1950			1960		
	Census	TLF	ALF	Census	TLF	ALF
<u>Northern Africa</u>						
Algeria	1948	2343700	1703500	1954	2531100	1572700
Morocco	1952	2338600	1442700	1960	2909000	1718000
Sudan	--	--	--	1956	3069500	2605400
Tunisia	1946	796000	492000	1956	1052000	608500
U.A.R.	1947	5845000	3258500	1960	6476000	3542000
<u>Western Africa</u>						
Ghana	--	--	--	1960	1683000	988000
Liberia	--	--	--	1962	256800	180900
Niger	--	--	--	1960	688000	667000
Nigeria	1952	7434500	5841800	--	--	--
Senegal	--	--	--	1960	--	612000
Sierra Leone	--	--	--	1963	585100	390400
Togo	--	--	--	1960	329000	269000
Upper Volta	--	--	--	1960	1122000	800000
<u>Eastern Africa</u>						
Mozambique	1950	1502000	1109000	--	--	--
<u>Middle and Southern Africa</u>						
Botswana	--	--	--	1964	112700	97600
Congo- Brazzaville	--	--	--	--	199200	93200
Gabon	--	--	--	1963	118200	89900
Swaziland	1946	98200	81500	--	--	--

^a Countries for which there are no TLF or ALF data for either 1950 or 1960 are not included in this table. For a list of these countries, by subregions, see the last page of the table.

Appendix Table II (continued)

Region and Country	1950			1960		
	Census	TLF	ALF	Census	TLF	ALF
<u>South Africa</u>						
South Africa	1951	3611600	1392900	1960	4404000	1573000
<u>Northern America</u>						
Canada	1951	4066700	983400	1961	4665400	710700
Greenland	1951	5800	3500	1960	8600	4000
U.S.A.	1950	43754000	6537000	1960	47468000	3872000
<u>Middle America</u>						
Br. Honduras	1946	17600	7800	1960	21300	9500
Costa Rica	1950	215000	132000	1963	287700	162500
El Salvador	1950	501000	360000	1961	601800	418600
Guatemala	1950	762000	562000	1964	949600	675400
Honduras	1950	330000	268000	1961	438300	325500
Mexico	1950	6765000	3946000	1960	8812000	5215000
Nicaragua	1950	284000	218000	1963	331300	254000
Panama	1950	205000	116000	1960	256000	140000
<u>Caribbean</u>						
Cuba	1953	1606000	746700	--	--	--
Dominican Rep.	1950	673000	434000	1960	732000	496000
Haiti	1950	868000	758000	--	--	--
Jamaica	--	--	--	1960	382000	190000
Puerto Rico	1950	459000	206000	1960	450000	125000
Trinidad & Tobago	1946	172700	43700	1960	203000	43000
<u>Tropical South America</u>						
Bolivia	1950	717000	478000	--	--	--
Brazil	1950	13628000	8306000	1960	17611000	9548000
Colombia	1951	2874400	1834200	1964	3588800	2064100
Ecuador	1950	834000	523000	1962	1077300	669100
Fr. Guiana	--	--	--	1961	8100	2500

Appendix Table II (continued)

Region and Country	1950			1960		
	Census	TLF	ALF	Census	TLF	ALF
Guyana	1946	111500	48400	1960	133000	47000
Peru	--	--	--	1961	2337200	1261000
Venezuela	1950	1339000	562000	1961	1800800	666500
<u>Temperate South America</u>						
Argentina	1947	5321100	1487800	1960	5884000	1344000
Chile	1952	1567600	552600	1960	1825000	617000
Paraguay	1950	330000	206000	1962	417000	266800
Uruguay	--	--	--	1963	728500	167500
<u>East Asia</u>						
Taiwan	1950	2230000	1273000	1960	2599000	1333000
Korea, South	--	--	--	1960	5322000	3185000
<u>Japan</u>						
Japan	1950	21831000	8623000	1960	26822000	6853000
<u>Southeast Asia</u>						
Cambodia	--	--	--	1962	1301500	976800
Indonesia	--	--	--	1961	23538000	16389700
Malaya	1947	1503100	867300	1957	1644800	799000
Philippines	1948	4488000	2934900	1960	6006000	4131000
Sabah	--	--	--	1960	123000	89000
Sarawak	--	--	--	1960	184000	136000
Thailand	1954	4429800	3880600	1960	6658000	5124000
<u>Southwest Asia</u>						
Cyprus	1946	140400	50500	1960	158000	43000
Iran	--	--	--	1956	5814700	3491900
Iraq	--	--	--	1957	1492900	804000
Israel	1954	398800	76400	1961	515500	77800
Jordan	--	--	--	1961	348400	123600
Syria	--	--	--	1960	853000	429000
Turkey	1950	5969000	4389000	1960	7697000	4685000

Appendix Table II (continued)

Region and Country	1950			1960		
	Census	TLF	ALF	Census	TLF	ALF
<u>South Central Asia</u>						
Ceylon	1953	2096500	1070900	1963	2533100	1128800
India	1951	91508900	62123300	1961	117505700	79069500
Nepal	1952	2261800	2070400	1961	2534900	2324800
Pakistan, East	1951	10834200	8965900	1961	13040900	10867000
Pakistan, West	1951	8815000	5767800	1961	10634500	6161200
<u>Northern Europe</u>						
Denmark	1950	1356000	386000	1960	1447000	336000
Finland	1950	1173000	539000	1960	1229000	458000
Iceland	1950	45000	15300	--	--	--
Ireland	1951	951600	452300	1961	832000	359100
Norway	1950	1060000	224000	1960	1085000	260000
Sweden	1950	2296000	580000	1960	2278000	401000
United Kingdom	1951	15566600	1153100	1961	16546600	975200
<u>Western Europe</u>						
Austria	1951	2060600	536300	1961	2014500	371400
Belgium	1947	2662100	332400	1961	2587300	226500
France	1954	12183100	3695200	1962	12996000	2801800
Germany, Fed Rep.	1950	14125000	2316000	1961	16616800	1678100
Netherlands	1947	2990000	519500	1960	3225000	407000
Switzerland	1950	1515000	333000	1960	1756000	263000
<u>Eastern Europe</u>						
Czechoslo- vakia	1950	3568000	1123000	--	--	--
Germany, Dem Rep.	1952	4541300	868100	1960	4475000	772000
Hungary	1947	2998200	1199600	1960	3165000	969000

Appendix Table II (continued)

Region and Country	1950			1960		
	Census	TLF	ALF	Census	TLF	ALF
Poland	1950	6858000	3295000	1960	7753000	3009000
<u>Southern Europe</u>						
Albania	--	--	--	1960	428000	239000
Greece	1951	2246000	1099100	1961	2357500	1128000
Italy	1951	15175200	6111100	1961	14904700	4191100
Portugal	1950	2453000	1258000	1960	2580000	1238000
Spain	1950	9084000	4828000	1960	9514000	4268000
Yugoslavia	1953	4477400	2736800	1961	5211200	2645000
<u>Australia-New Zealand</u>						
Australia	1947	2603300	439600	1961	3102100	431700
New Zealand	1951	559700	129900	1961	659100	120800
<u>Oceania</u>						
Fiji Is.	1946	81800	44200	1956	92300	59700
New Caledonia	--	--	--	1963	20800	7500
<u>U.S.S.R.</u>						
U.S.S.R.	--	--	--	1959	53362700	17973100

NOTE: The following countries were not included in this table because neither TLF nor ALF data were available for them for 1950 or 1960: Northern Africa--Libya, Spanish Sahara; Western Africa--Dahomey, Gambia, Guinea, Ivory Coast, Mali, Mauritania, Port. Guinea; Eastern Africa--Burundi, Ethiopia, Fr. Somaliland, Kenya, Madagascar, Malawi, Rwanda, Somalia, South Rhodesia, Tanganyika, Uganda, Zambia; Middle and Southern Africa--Angola, Cameroon, Central Afr Rep., Chad, Congo Republic, Lesotho, Southwest Africa, Sp. Eq. Guinea; Caribbean--Bahama Is.; Tropical South America--Surinam; Temperate South America--Falkland Is.; East Asia--China, North Korea, Mongolia; Southeast Asia--Burma, Laos, Port. Timor, North Vietnam, South Vietnam, West Irian; Southwest Asia--Fed. South Arabia, Kuwait, Lebanon, Muscat & Oman, Qatar, Saudi Arabia, Trucial Oman, Yemen; South Central Asia--Afghanistan, Bhutan, Sikkim; Eastern Europe--Bulgaria, Romania; Oceania--New Guinea, New Hebrides, Papua Is., Solomon Is.-U.K.

Appendix Table III

FARM POPULATION AND INDEX OF AGRICULTURAL PRODUCTION:
1950 AND 1960

Region and Country ^a	1950		1960		Index of Agricultural Production ^c	
	Source	Farm Popula- tion ^b	Source	Farm Popula- tion	1950	1960
<u>Northern Africa</u>						
Algeria	Pop Cen 1948	6110000	Est 1965	6635500	101.4	95.3
Libya	--	--	Agr Cen 1960	855000	--	--
Morocco	--	--	--	--	100.3	97.7
Tunisia	--	--	--	--	98.7	104.3
U.A.R.	--	--	--	--	88.3	120.0
<u>Western Africa</u>						
Ghana	Agr Cen 1950	3008000	Est 1963	4199700	--	--
Mali	--	--	Agr S. Cen 1960	2885000	--	--
Port. Guinea	--	--	Agr Cen 1960	514000	--	--
Senegal	--	--	Agr S. Cen 1960	1894000	--	--
Sierra Leone	Est 1950	1755000	Est 1965	1981800	--	--
Togo	--	--	Agr Cen 1960	1308000	--	--
<u>Eastern Africa</u>						
Ethiopia	--	--	Est 1962	17963900	85.0	123.3
Madagascar	--	--	Agr S. Cen 1961	4183600	--	--

^aCountries for which there are no farm population or agricultural production data for either 1950 or 1960 are not included in this table. For a list of these countries, by subregions, see the last page of the table.

^bThe concept of "farm population" is discussed in Chapter II, pp. 24-26.

^cFor explanation of Index, see Chapter VI, p. 201.

Appendix Table III (continued)

Region and Country	1950		1960		Index of Agr. Prod.	
	Source	Farm Pop.	Source	Farm Pop.	1950	1960
Malawi	Est 1949	2134500	Est 1965	2791300	--	--
Mozambique	--	--	Est 1962	4579900	--	--
South Rhodesia	--	--	Est 1962	2824500	--	--
Zambia	Est 1950	1423000	Est 1965	2342000	--	--
<u>Middle and Southern Africa</u>						
Botswana	--	--	Agr Cen 1964	204400	--	--
Central Afr Rep.	--	--	Agr S. Cen 1960	935000	--	--
Congo- Brazzaville	--	--	Est 1960	545000	--	--
Gabon	--	--	Est 1961	330700	--	--
Southwest Africa	--	--	Agr Cen 1960	396000	--	--
<u>South Africa</u>						
South Africa	--	--	Agr Cen 1960	6995000	82.0	125.0
<u>Northern America</u>						
Canada	Pop Cen 1951	2917200	Pop Cen 1961	2138400	101.2	99.7
Greenland	--	--	Est 1950	12000	--	--
U.S.A.	Pop Cen 1950	22990000	Pop Cen 1960	13461000	93.3	109.7
<u>Middle America</u>						
Costa Rica	--	--	Agr Cen 1963	607200	--	--
Guatemala	Agr Cen 1950	1728000	--	--	78.8	134.7
Honduras	--	--	--	--	88.9	120.0
Mexico	--	--	--	--	69.9	144.7
Panama	Agr Cen 1950	412000	Agr Cen 1961	477000	85.7	122.3

Appendix Table III (continued)

Region and Country	1950		1960		Index of Agr. Prod.	
	Source	Farm Pop.	Source	Farm Pop.	1950	1960
<u>Caribbean</u>						
Cuba	--	--	--	--	90.4	117.0
Dominican Rep.	Agr Cen 1950	985000	--	--	--	--
Jamaica	Agr S. Cen 1954	1006500	Agr Cen 1961	761000	--	--
Trinidad & Tobago	Est 1951	129300	Est 1965	171200	--	--
<u>Tropical South America</u>						
Brazil	--	--	--	--	74.8	143.0
Colombia	Est 1951	6145100	Agr Cen 1960	6556000	90.7	116.7
Peru	--	--	--	--	89.5	117.0
Surinam	--	--	Agr Cen 1959	95200	--	--
Venezuela	Est 1950	1986000	Pop Cen 1961	2400100	82.6	126.3
<u>Temperate South America</u>						
Argentina	Agr Cen 1952	4009300	Est 1965	4148700	96.4	104.7
Chile	--	--	Agr Cen 1965	1670000	93.3	112.7
Falkland Is.	Est 1950	800	--	--	--	--
Paraguay	Est 1950	784000	Est 1965	933100	--	--
Uruguay	Agr Cen 1950	454000	Agr Cen 1961	395400	106.6	86.7
<u>East Asia</u>						
Taiwan	Est 1950	4231600	Agr Cen 1960	5591300	80.2	128.3
China	Est 1948	404712200	Est 1965	454093700	--	--
Korea, South	Agr Cen 1955	14682000	Agr Cen 1961	14282400	82.2	125.0

Appendix Table III (continued)

Region and Country	1950		1960		Index of Agr. Prod.	
	Source	Farm Pop.	Source	Farm Pop.	1950	1960
<u>Japan</u>						
Japan	Agr Cen 1950	37811000	Agr Cen 1960	34546000	86.5	118.7
<u>Southeast Asia</u>						
Burma	--	--	--	--	91.8	113.3
Cambodia	--	--	Est 1958	3512700	--	--
Indonesia	--	--	--	--	94.3	108.7
Malaya	--	--	Agr Cen 1960	2735000	83.1	125.7
Philippines	Agr Cen 1948	13072000	Agr Cen 1960	12140000	86.1	120.7
Sabah	--	--	Agr Cen 1961	231900	--	--
Sarawak	--	--	Agr Cen 1960	478000	--	--
Thailand	--	--	Pop Cen 1960	19590000	78.6	127.7
Vietnam, South	--	--	Agr Cen 1960	10033000	--	--
<u>Southwest Asia</u>						
Cyprus	Est 1950	250000	Est 1965	239000	--	--
Iran	--	--	Agr Cen 1960	12096000	82.4	125.7
Iraq	--	--	--	--	96.9	102.3
Israel	Agr Cen 1950	226000	Est 1965	279000	52.6	174.0
Syria	--	--	Pop Cen 1960	2571000	94.1	106.0
Turkey	--	--	Agr S. Cen 1963	12605000	86.0	126.3
<u>South Central Asia</u>						
Ceylon	--	--	--	--	88.6	117.0

Appendix Table III (continued)

Region and Country	1950		1960		Index of Agr. Prod.	
	Source	Farm Pop.	Source	Farm Pop.	1950	1960
India	Pop Cen 1951	233475500	Pop Cen 1961	260834600	86.3	119.3
Pakistan, East	--	--	--	--	92.7	112.3
Pakistan, West	--	--	--	--	92.7	112.3
<u>Northern Europe</u>						
Denmark	Pop Cen 1950	1014000	Pop Cen 1960	854000	91.5	115.7
Finland	Pop Cen 1950	1688800	Pop Cen 1960	1420400	88.3	121.3
Iceland	Est 1950	29000	--	--	--	--
Ireland	Pop Cen 1951	1144100	Pop Cen 1961	987600	92.5	108.7
Norway	Pop Cen 1950	713000	Pop Cen 1960	548000	97.3	101.3
Sweden	Pop Cen 1950	1647000	Pop Cen 1960	924000	100.8	100.7
United Kingdom	Pop Cen 1951	3070400	Pop Cen 1961	2157800	88.8	117.0
<u>Western Europe</u>						
Austria	Pop Cen 1951	1562500	Pop Cen 1960	1155000	86.4	118.9
Belgium	Agr Cen 1950	1116000	Agr Cen 1959	1030000	92.9	109.0
France	Pop Cen 1954	10784600	Pop Cen 1962	7918400	90.2	116.7
Germany, Fed Rep.	Agr Cen 1950	9404000	Agr Cen 1960	5294000	92.1	112.3
Netherlands	Agr Cen 1950	1405000	Agr Cen 1959	1413900	90.8	117.7
Switzerland	Pop Cen 1950	834700	Pop Cen 1960	679300	95.8	108.7
<u>Eastern Europe</u>						
Hungary	--	--	Est 1960	3583000	--	--

Appendix Table III (continued)

Region and Country	1950		1960		Index of Agr. Prod.	
	Source	Farm Pop.	Source	Farm Pop.	1950	1960
Poland	Pop Cen 1950	11779000	Pop Cen 1960	11434000	--	--
<u>Southern Europe</u>						
Albania	--	--	Pop Cen 1960	946000	--	--
Greece	Pop Cen 1951	3012800	Pop Cen 1961	2906000	80.8	126.7
Italy	Pop Cen 1951	17335500	Pop Cen 1961	12606300	91.6	113.0
Portugal	Pop Cen 1950	3514000	Pop Cen 1960	3743000	97.6	101.7
Spain	Pop Cen 1950	13250000	Est 1965	12306300	89.1	119.0
Yugoslavia	Pop Cen 1953	10722000	Pop Cen 1961	9427500	76.6	143.3
<u>Australia-New Zealand</u>						
Australia	Agr Cen 1950	963000	Agr Cen 1960	1022000	85.0	123.0
New Zealand	Agr Cen 1950	373000	Est 1965	354100	85.8	122.3
<u>Oceania</u>						
Fiji Is.	Est 1950	94000	--	--	--	--
New Caledonia	--	--	Pop Cen 1963	23100	--	--
New Hebrides	Est 1950	48000	--	--	--	--
Solomon Is.- U.K.	Agr Cen 1950	98000	--	--	--	--
<u>U.S.S.R.</u>						
U.S.S.R.	Est 1950	90000000	Est 1965	78276000	--	--

NOTE: The following countries were not included in this table because neither farm population nor agricultural production data were available for them for either 1950 or 1960:

Appendix Table III (continued)

Northern Africa--Spanish Sahara, Sudan; Western Africa--Dahomey, Gambia, Guinea, Ivory Coast, Liberia, Mauritania, Niger, Nigeria, Upper Volta; Eastern Africa--Burundi, Fr. Somaliland, Kenya, Rwanda, Somalia, Tanganyika, Uganda; Middle and Southern Africa--Angola, Cameroon, Chad, Congo Republic, Lesotho, Sp. Eq. Guinea, Swaziland; Middle America--Br. Honduras, El Salvador, Nicaragua; Caribbean--Bahama Is., Haiti, Puerto Rico; Tropical South America--Bolivia, Ecuador, Fr. Guiana, Guyana; East Asia--Mongolia; South-east Asia--Laos, Port. Timor, North Vietnam, West Irian; Southwest Asia--Fed. South Arabia, Jordan, Kuwait, Lebanon, Muscat & Oman, Qatar, Saudi Arabia, Trucial Oman, Yemen; South Central Asia--Afghanistan, Bhutan, Nepal, Sikkim; Eastern Europe--Bulgaria, Czechoslovakia, Dem. Rep. Germany, Romania; Oceania--New Guinea, Papua Is.

Appendix Table IV

ELECTRICITY PRODUCTION AND LOGARITHMS (BASE E) OF
PER CAPITA ELECTRICITY PRODUCTION: 1950 AND 1960

(Electricity data in 100,000 kwh.)

Economic Level and Country	Period	Electricity Production	Period	Electricity Production	Log of Per Capita Production	
					1950	1960
Economic Level 1*						
Sudan	1948-52	209	1958-62	920	0.848	2.056
Dahomey	--	--	1958-62	90	--	1.479
Gambia	1948-52	13	1958-62	59	1.598	2.986
Mali	--	--	1958-62	143	--	1.240
Niger	--	--	1958-62	81	--	1.035
Nigeria	1949-51	1250	1958-62	5334	1.411	2.452
Port. Guinea	--	--	1959-60	25	--	1.568
Sierra Leone	1948-52	64	1958-62	457	1.161	3.021
Togo	1948-52	10	1962	143	-0.095	2.296
Upper Volta	--	--	1958-62	85	--	0.658
Ethiopia	1950	172	1958-62	1092	0.072	1.663
Madagas- car	1949-51	372	1958-62	1068	2.168	2.986
Malawi	1950-51	25	1958-62	299	-0.092	2.148
Rwanda	1948-52	8	1958-60	169	-0.941	1.846
Somalia	--	--	1958-62	53	--	0.970
Tangan- yika	1948-52	431	1958-62	1571	1.718	2.834

* No electricity production data for either 1950 or 1960 were available for the following countries in Economic Level 1: Spanish Sahara, Mauritania, Burundi, Botswana, Lesotho, Sp. Eq. Guinea, Swaziland, Falkland Is., Port. Timor, Fed. South Arabia, Muscat & Oman, Qatar, Trucial Oman, Yemen, Bhutan, Sikkim, Solomon Is.,-U.K.

Appendix Table IV (continued)

Econ. Level & Country	Period	Electricity		Electricity Production	Log of Per Cap. Prod.	
		Production	Period		1950	1960
Central Afr. Rep.	--	--	1958-62	86	--	1.945
Chad	--	--	1958-62	78	--	0.932
Haiti	1949-51	200	1958-62	596	1.865	2.704
Burma	1950-51	1143	1958-62	4420	1.807	2.984
Cambodia	1951	189	1958-62	614	1.535	2.424
Indonesia	1950-51	5530	1958-62	11574	1.985	2.516
Laos	1951	43	1959-60	122	1.181	1.656
Vietnam, North	--	--	1958-62	2576	--	2.773
Vietnam, South	1950-51	1987	1958-62	3046	2.940	3.073
West Irian	1951	27	--	--	1.350	--
Jordan	--	--	1962	104	--	1.814
Saudi Arabia	--	--	1958-62	404	--	1.874
Afghani- stan	1950-51	241	1958-62	1080	0.697	2.019
Nepal	--	--	1958-62	116	--	0.234
Pakistan, East	1948-52	196	1958-62	2388	-0.741	1.566
New Hebrides	--	--	1961	12	--	2.996
<u>Economic Level 2</u>						
Algeria	1948-52	5826	1958-62	12384	4.179	4.744
Libya	--	--	1958-62	1024	--	4.330
Morocco	1948-52	5160	1958-62	10140	4.053	4.467
Tunisia	1948-52	1588	1958-62	3128	3.799	4.321
U.A.R.	1950	8812	1958-62	29004	3.763	4.711
Ghana	1949-51	1923	1958-62	3694	3.681	4.006
Guinea	--	--	1958-62	870	--	3.344

Appendix Table IV (continued)

Econ. Level & Country	Period	Electricity		Electricity Production	Log of Per Cap. Prod.	
		Production	Period		1950	1960
Ivory Coast	--	--	1958-62	742	--	3.134
Liberia	1948-52	143	1958-62	997	2.811	4.614
Senegal	--	--	1958-62	1304	--	3.736
Fr. Soma- liland	1948-52	15	1958-62	97	3.270	4.783
Kenya	1950-51	1057	1958-62	2204	2.866	3.302
Mozam- bique	1948-52	414	1958-62	1498	1.976	3.125
Uganda	1948-52	207	1958-62	3818	1.382	4.046
Angola	1949-50	237	1958-62	1520	1.744	3.449
Cameroon	--	--	1959-61	9078	--	5.263
Congo Brazza- ville	--	--	1958-62	294	--	3.638
Congo Re- public	1948-52	6006	1958-62	26055	3.965	5.216
Gabon	--	--	1958-62	197	--	3.802
Br. Honduras	--	--	1958-62	57	--	4.147
El Salva- dor	1949-51	1290	1958-62	2528	4.241	4.635
Guatemala	1948-52	700	1958-62	2716	3.222	4.267
Honduras	1949-51	510	1958-62	946	3.564	3.887
Nicaragua	1948-52	820	1958-62	1796	4.351	4.846
Dominican Rep.	1948-52	1686	1958-62	3520	4.369	4.754
Bolivia	1949-51	3150	1958-62	4564	4.648	4.884
Ecuador	1949-51	1400	1958-62	3844	3.778	4.481
Fr. Gufana	1949-51	5	1958-62	44	2.996	4.893
Guyana	1951	377	1958-62	1010	4.490	5.195
Paraguay	1949-51	370	1958-62	938	3.315	3.981

Appendix Table IV (continued)

Econ. Level & Country	Period	Electricity Production	Period	Electricity Production	Log of Per Cap. Prod.	
					1950	1960
China	1948-52	52933	1958-62	500000	2.246	4.313
Korea, South	1948-52	5070	1958-62	18056	3.207	4.280
Mongolia	--	--	1958-62	1166	--	4.807
Malaya	1949-51	6203	1958-62	11638	4.783	5.127
Philip- pines	1950-51	7813	1958-62	27392	3.652	4.616
Sabah	--	--	1958-62	182	--	3.691
Sarawak	1948-52	42	1960-61	360	1.971	3.871
Thailand	1949-51	659	1959-61	5907	1.211	3.113
Iran	--	--	1959	9070	--	3.742
Iraq	1948-52	1364	1958-62	8296	3.271	4.799
Lebanon	1948-52	1152	1958-62	4210	4.174	5.296
Syria	--	--	1958-62	3856	--	4.437
Turkey	1948-52	8221	1958-62	28550	3.677	4.642
Ceylon	1948-52	903	1958-62	3108	2.465	3.447
India	1948-52	53132	1958-62	205032	2.709	3.863
Pakistan, West	1948-52	2442	1958-62	13819	2.003	3.497
Albania	1950	214	1958-62	1976	2.865	4.800
Fiji Is.	1953	60	1958-62	534	3.033	4.909
New Guinea	--	--	1958-62	362	--	3.251
Papua Is.	1952	59	1958-62	214	2.761	3.751
<u>Economic Level 3</u>						
South Rhodesia	1948-52	5238	1958-62	22308	5.286	6.418
Zambia	1950-51	8490	1958-62	8616	5.852	5.593
Southwest Africa	--	--	1958-62	1868	--	5.872
Costa Rica	1949-51	1600	1958-62	4284	5.292	5.902
Mexico	1948-52	45930	1958-62	107830	5.182	5.733

Appendix Table IV (continued)

Econ. Level & Country	Period	Electricity Production	Period	Electricity Production	Log of Per Cap. Prod.	
					1950	1960
Panama	1949-51	850	1958-62	2384	4.660	5.401
Bahama Is.	1948-52	169	1958-62	766	5.366	6.476
Cuba	1949-51	12000	1958-62	28808	5.382	6.045
Jamaica	--	--	1958-62	5124	--	5.751
Trinidad & Tobago	1950	1155	1958-62	4708	5.208	6.343
Brazil	1948-52	81742	1958-62	230604	5.057	5.783
Colombia	1948-52	11484	1958-62	36506	4.662	5.478
Peru	1948-52	9088	1958-62	25754	4.694	5.454
Surinam	--	--	1958-62	832	--	5.720
Venezuela	1949-51	11483	1959-61	67259	5.418	6.466
Argentina	1948-52	51330	1958-62	105710	5.706	6.270
Chile	1948-52	30044	1958-62	47018	6.204	6.405
Uruguay	1949-51	6237	1958-62	13086	5.650	6.246
Taiwan	1948-52	10884	1958-62	38582	4.962	5.896
Cyprus	1948-52	157	1958-62	2396	3.459	6.034
Bulgaria	1948-52	9134	1958-62	46002	4.836	6.371
Romania	1948-52	22338	1958-62	78804	4.920	6.060
Greece	1948-52	7346	1958-62	23020	4.577	5.622
Portugal	1948-52	9942	1958-62	32738	4.769	5.909
Spain	1948-52	72718	1958-62	192200	5.560	6.448
Yugo- slavia	1948-52	23702	1958-62	91178	4.977	6.206
New Cale- donia	1951	51	1960	475	4.394	6.412
<u>Economic Level 4</u>						
South Africa	1948-52	109116	1958-62	227848	6.775	7.261
Canada	1948-52	561484	1958-62	1095672	8.316	8.719
Greenland	1949-51	11	1958-62	262	3.868	6.674

Appendix Table IV (continued)

Econ. Level & Country	Period	Electricity		Electricity Production	Log of Per Cap. Prod.	
		Production	Period		1950	1960
U.S.A.	1948-52	3933924	1958-62	8392060	7.860	8.443
Puerto Rico	1948-52	5936	1958-62	21694	5.593	6.828
Korea, North	--	--	1958-62	92888	--	6.776
Japan	1948-52	441642	1958-62	1144780	6.272	7.111
Israel	1948-52	5416	1958-62	23058	6.065	6.995
Kuwait	1950	49	1958-62	2692	3.361	6.876
Denmark	1948-52	22560	1958-62	49210	6.267	6.978
Finland	1948-52	40172	1958-62	93106	6.905	7.647
Iceland	1948-52	1922	1958-62	5470	7.203	8.042
Ireland	1948-52	8986	1958-62	22814	5.713	6.691
Norway	1948-52	82758	1958-62	316532	7.834	9.084
Sweden	1948-52	176394	1958-62	352500	7.826	8.456
United Kingdom	1948-52	568370	1958-62	1355804	7.024	7.855
Austria	1948-52	65180	1958-62	157500	6.846	7.712
Belgium	1948-52	87026	1958-62	152602	6.915	7.419
France	1948-52	345068	1958-62	715612	6.718	7.357
Germany, Fed Rep.	1948-52	450068	1958-62	1161728	6.787	7.648
Nether-lands	1948-52	71682	1958-62	164438	6.563	7.269
Switzer-land	1948-52	111576	1958-62	195550	7.769	8.189
Czechoslo- vakia	1948-52	94770	1958-62	243296	6.644	7.485
Germany, Dem Rep.	1948-52	188200	1958-62	400010	6.931	7.749
Hungary	1948-52	29954	1958-62	77380	5.771	6.655
Poland	1948-52	95366	1958-62	294572	5.944	6.897
Italy	1948-52	256446	1958-62	553012	6.307	7.016

Appendix Table IV (continued)

<u>Econ. Level & Country</u>	<u>Period</u>	<u>Electricity</u>		<u>Electricity</u>	<u>Log of Per</u>	
		<u>Production</u>	<u>Period</u>	<u>Production</u>	<u>Cap. Prod.</u>	<u>1950 1960</u>
Australia	1948-52	97444	1958-62	230566	7.073	7.705
New Zealand	1948-52	31990	1958-62	68446	7.425	7.967
U.S.S.R.	1948-52	907400	1958-62	2979246	6.223	7.237

Appendix Table V

RATIOS OF VARIOUS POPULATION GROUPS: 1950 AND 1960

Region and Country*	Year	Rural/ Tot Pop x 100	ALF/TLF x 100	Farm/ Rural x 100	Rural/ ALF	Farm/ ALF
<u>Northern Africa</u>						
Algeria (2)	1950	75.527	72.684	90.693	3.955	3.587
	1960	68.787	62.135	89.451	4.717	4.219
Libya (2)	1950	78.779	--	--	--	--
	1960	75.389	--	84.071	--	--
Morocco (2)	1950	76.872	61.691	--	4.774	--
	1960	70.902	59.058	--	4.804	--
Spanish Sahara (1)	1950	81.000	--	--	--	--
	1960	57.983	--	--	--	--
Sudan (1)	1950	93.654	--	--	--	--
	1960	92.710	84.880	--	4.188	--
Tunisia (2)	1950	69.395	61.809	--	5.014	--
	1960	62.978	57.842	--	4.302	--
U.A.R. (2)	1950	68.159	55.749	--	4.280	--
	1960	62.185	54.694	--	4.580	--
<u>Western Africa</u>						
Dahomey (1)	1950	91.401	--	--	--	--
	1960	88.098	--	--	--	--
Gambia (1)	1950	92.852	--	--	--	--
	1960	91.443	--	--	--	--
Ghana (2)	1950	85.779	--	72.377	--	--
	1960	76.944	58.705	81.138	5.239	4.251
Guinea (2)	1950	94.711	--	--	--	--
	1960	92.187	--	--	--	--
Ivory Coast (2)	1950	92.382	--	--	--	--
	1960	84.180	--	--	--	--
Liberia (2)	1950	95.081	--	--	--	--
	1960	87.045	70.444	--	4.754	--
Mali (1)	1950	95.907	--	--	--	--
	1960	94.034	--	74.107	--	--
Mauritania (1)	1950	97.893	--	--	--	--
	1960	97.732	--	--	--	--
Niger (1)	1950	97.718	--	--	--	--
	1960	97.354	96.948	--	4.198	--

*Numbers in parentheses indicate countries' economic levels.

Appendix Table V (continued)

Region and Country	Year	Rural/ Tot Pop × 100	ALF/TLF × 100	Farm/ Rural × 100	Rural/ ALF	Farm/ ALF
Nigeria (1)	1950	86,885	78,577	--	4,536	--
	1960	83,232	--	--	--	--
Port. Guinea (1)	1950	89,961	--	--	--	--
	1960	86,296	--	114,324	--	--
Senegal (2)	1950	80,172	--	--	--	--
	1960	76,527	--	79,580	3,889	3,095
Sierra Leone (1)	1950	91,267	--	95,954	--	--
	1960	88,779	66,724	100,192	5,067	5,076
Togo (1)	1950	94,673	--	--	--	--
	1960	90,347	81,763	100,538	4,836	4,862
Upper Volta (1)	1950	97,297	--	--	--	--
	1960	96,368	71,301	--	5,300	--
<u>Eastern Africa</u>						
Burundi (1)	1950	99,033	--	--	--	--
	1960	98,398	--	--	--	--
Ethiopia (1)	1950	94,062	--	--	--	--
	1960	93,720	--	92,597	--	--
Fr. Somali- land (2)	1950	66,667	--	--	--	--
	1960	54,680	--	--	--	--
Kenya (2)	1950	94,816	--	--	--	--
	1960	92,532	--	--	--	--
Madagascar (1)	1950	91,095	--	--	--	--
	1960	89,190	--	86,977	--	--
Malawi (1)	1950	98,759	--	78,880	--	--
	1960	97,378	--	82,133	--	--
Mozambique (2)	1950	97,804	73,835	--	5,061	--
	1960	96,352	--	72,250	--	--
Rwanda (1)	1950	99,893	--	--	--	--
	1960	99,831	--	--	--	--
Somalia (1)	1950	84,040	--	--	--	--
	1960	80,100	--	--	--	--
South Rhodesia (3)	1950	90,347	--	--	--	--
	1960	83,736	--	92,667	--	--
Tanganyika (1)	1950	96,961	--	--	--	--
	1960	95,302	--	--	--	--

Appendix Table V (continued)

Region and Country	Year	Rural Tot Pop × 100	ALF/TLF × 100	Farm/ Rural × 100	Rural/ ALF	Farm/ ALF
Uganda (2)	1950	98,038	--	--	--	--
	1960	96,196	--	--	--	--
Zambia (3)	1950	87,008	--	67,028	--	--
	1960	80,997	--	90,077	--	--
<u>Middle and Southern Africa</u>						
Angola (2)	1950	94,041	--	--	--	--
	1960	91,886	--	--	--	--
Botswana (1)	1950	79,702	--	--	--	--
	1960	79,089	86,602	53,508	3,914	2,094
Cameroon (2)	1950	94,857	--	--	--	--
	1960	91,745	--	--	--	--
Central Afr. Rep. (1)	1950	92,845	--	--	--	--
	1960	86,341	--	88,041	--	--
Chad (1)	1950	97,779	--	--	--	--
	1960	95,798	--	--	--	--
Congo Brazza- ville (2)	1950	83,852	--	--	--	--
	1960	73,609	46,787	95,782	6,105	5,868
Congo Republic (2)	1950	92,537	--	--	--	--
	1960	85,515	--	--	--	--
Gabon (2)	1950	93,325	--	--	--	--
	1960	87,727	76,058	85,674	4,294	3,679
Lesotho (1)	1950	99,350	--	--	--	--
	1960	98,960	--	--	--	--
Southwest Africa (3)	1950	85,095	--	--	--	--
	1960	76,616	--	98,263	--	--
Sp. Eq. Guinea (1)	1950	94,422	--	--	--	--
	1960	90,488	--	--	--	--
Swaziland (1)	1950	100,000	82,994	--	2,515	--
	1960	94,641	--	--	--	--
<u>South Africa</u>						
South Africa (4)	1950	60,860	38,567	--	5,443	--
	1960	55,133	35,718	79,281	5,609	4,647
<u>Northern America</u>						
Canada (4)	1950	38,269	24,182	55,492	5,346	2,966
	1960	31,453	15,233	37,962	7,926	3,009

Appendix Table V (continued)

Region and Country	Year	Rural Tot Pop x 100	ALF/TLF x 100	Farm/ Rural x 100	Rural/ ALF	Farm/ ALF
Greenland (4)	1950	91.739	60.345	--	6.029	--
	1960	90.332	46.512	40.134	7.475	3.000
U.S.A. (4)	1950	36.002	14.940	42.078	8.358	3.517
	1960	30.140	8.157	24.716	14.066	3.476
<u>Middle America</u>						
Br. Hon- duras (2)	1950	63.284	44.318	--	5.436	--
	1960	63.263	44.601	--	6.000	--
Costa Rica (3)	1950	66.708	61.395	--	4.068	--
	1960	65.243	56.482	79.476	4.702	3.737
El Salvador (2)	1950	63.524	71.856	--	3.275	--
	1960	61.858	69.558	--	3.626	--
Guatemala (2)	1950	75.063	73.753	82.482	3.728	3.075
	1960	69.318	71.125	--	3.910	--
Honduras (2)	1950	82.284	81.212	--	4.437	--
	1960	78.351	74.264	--	4.670	--
Mexico (3)	1950	57.415	58.330	--	3.753	--
	1960	49.303	59.181	--	3.302	--
Nicaragua (2)	1950	65.090	76.761	--	3.156	--
	1960	60.666	76.668	--	3.370	--
Panama (3)	1950	63.975	56.585	80.000	4.440	3.552
	1960	58.550	54.687	75.714	4.500	3.407
<u>Caribbean</u>						
Bahama Is. (3)	1950	61.519	--	--	--	--
	1960	53.729	--	--	--	--
Cuba (3)	1950	43.455	46.494	--	3.210	--
	1960	42.529	--	--	--	--
Dominican Rep. (2)	1950	76.217	64.487	60.504	3.751	2.270
	1960	69.733	67.760	--	4.264	--
Haiti (1)	1950	87.827	87.327	--	3.588	--
	1960	85.242	--	--	--	--
Jamaica (3)	1950	77.216	--	95.493	--	--
	1960	70.780	49.738	66.002	6.068	4.005
Puerto Rico (4)	1950	59.521	44.880	--	6.388	--
	1960	55.872	27.778	--	10.504	--
Trinidad & Tobago (3)	1950	74.051	25.304	27.628	10.709	2.959
	1960	60.386	21.182	34.240	11.628	3.981

Appendix Table V (continued)

Region and Country	Year	Rural Tot Pop x 100	ALF/TLF x 100	Farm/ Rural x 100	Rural/ ALF	Farm/ ALF
<u>Tropical South America</u>						
Bolivia (2)	1950	79.596	66.667	--	5.027	--
	1960	77.179	--	--	--	--
Brazil (3)	1950	63.894	60.948	--	4.002	--
	1960	54.961	54.216	--	4.089	--
Colombia (3)	1950	62.358	63.812	90.798	3.690	3.350
	1960	51.028	57.515	84.276	3.769	3.176
Ecuador (2)	1950	71.464	62.710	--	4.377	--
	1960	67.004	62.109	--	4.358	--
Fr. Guiana (2)	1950	55.200	--	--	--	--
	1960	49.394	30.864	--	6.520	--
Guyana (2)	1950	72.104	43.408	--	6.302	--
	1960	71.071	35.338	--	8.468	--
Peru (3)	1950	64.503	--	--	--	--
	1960	59.147	53.953	--	5.171	--
Surinam (3)	1950	65.789	--	--	--	--
	1960	63.956	--	54.525	--	--
Venezuela (3)	1950	54.811	41.972	71.157	4.966	3.534
	1960	37.570	37.011	86.929	4.143	3.601
<u>Temperate South America</u>						
Argentina (3)	1950	36.731	27.960	63.944	4.214	2.695
	1960	33.020	22.842	62.802	4.915	3.087
Chile (3)	1950	45.743	35.251	--	5.027	--
	1960	35.306	33.808	60.860	4.447	2.707
Falkland Is. (1)	1950	100.000	--	40.000	--	--
	1960	100.000	--	--	--	--
Paraguay (2)	1950	67.063	62.424	86.918	4.379	3.806
	1960	65.620	63.981	81.210	4.307	3.497
Uruguay (3)	1950	43.411	--	47.689	--	--
	1960	27.957	22.992	55.769	4.233	2.361
<u>East Asia</u>						
Taiwan (3)	1950	47.802	57.085	116.189	2.861	3.324
	1960	41.462	51.289	127.075	3.301	4.195
China (2)	1950	88.984	--	81.217	--	--
	1960	83.453	--	81.213	--	--

Appendix Table V (continued)

Region and Country	Year	Rural Tot Pop x 100	ALF/TLF x 100	Farm/ Rural x 100	Rural/ ALF	Farm/ ALF
Korea, North (4)	1950	87.000	--	--	--	--
	1960	81.132	--	--	--	--
Korea, South (2)	1950	81.719	--	87.586	--	--
	1960	72.000	59.846	79.382	5.649	4.484
Mongolia (2)	1950	80.191	--	--	--	--
	1960	65.058	--	--	--	--
<u>Japan</u>						
Japan (4)	1950	62.595	39.499	72.413	6.055	4.385
	1960	51.400	25.550	71.945	7.007	5.041
<u>Southeast Asia</u>						
Burma (1)	1950	87.078	--	--	--	--
	1960	85.686	--	--	--	--
Cambodia (1)	1950	92.145	--	--	--	--
	1960	89.890	75.052	71.834	5.006	3.596
Indonesia (1)	1950	87.714	--	--	--	--
	1960	85.066	69.631	--	4.853	--
Laos (1)	1950	93.500	--	--	--	--
	1960	91.416	--	--	--	--
Malaya (2)	1950	75.665	57.701	--	4.528	--
	1960	65.118	48.577	60.791	5.631	3.423
Philip- pines (2)	1950	80.128	65.394	80.463	5.535	4.454
	1960	78.507	68.781	57.086	5.148	2.939
Port. Timor (1)	1950	90.136	--	--	--	--
	1960	89.903	--	--	--	--
Sabah (2)	1950	86.758	--	--	--	--
	1960	85.088	72.358	60.031	4.340	2.606
Sarawak (2)	1950	88.513	--	--	--	--
	1960	85.067	73.913	74.922	4.691	3.515
Thailand (2)	1950	89.972	87.602	--	4.552	--
	1960	88.560	76.960	84.264	4.538	3.823
Vietnam, North (1)	1950	92.242	--	--	--	--
	1960	85.783	--	--	--	--
Vietnam, South (1)	1950	83.800	--	--	--	--
	1960	79.121	--	89.934	--	--
West Irian (1)	1950	98.114	--	--	--	--
	1960	97.986	--	--	--	--

Appendix Table V (continued)

Region and Country	Year	Rural Tot Pop x 100	ALF/TLF x 100	Farm/ Rural x 100	Rural/ ALF	Farm/ ALF
<u>Southwest Asia</u>						
Cyprus (3)	1950	75.709	35.969	66.845	7.406	4.950
	1960	64.111	27.215	64.946	8.558	5.558
Fed. South Arabia (1)	1950	81.178	--	--	--	--
	1960	71.984	--	--	--	--
Iran (2)	1950	73.292	--	--	--	--
	1960	67.074	60.053	83.878	4.130	3.464
Iraq (2)	1950	65.116	--	--	--	--
	1960	60.767	53.855	--	5.163	--
Israel (4)	1950	20.191	19.157	88.976	3.325	2.958
	1960	22.564	15.092	58.491	6.131	3.586
Jordan (1)	1950	65.349	--	--	--	--
	1960	60.649	35.476	--	8.317	--
Kuwait (4)	1950	42.353	--	--	--	--
	1960	29.856	--	--	--	--
Lebanon (2)	1950	73.491	--	--	--	--
	1960	66.919	--	--	--	--
Muscat & Oman (1)	1950	97.636	--	--	--	--
	1960	96.460	--	--	--	--
Qatar (1)	1950	50.000	--	--	--	--
	1960	40.000	--	--	--	--
Saudi Arabia (1)	1950	90.476	--	--	--	--
	1960	83.871	--	--	--	--
Syria (2)	1950	64.672	--	--	--	--
	1960	63.056	50.293	89.395	6.704	5.993
Trucial Oman (1)	1950	75.000	--	--	--	--
	1960	60.000	--	--	--	--
Turkey (2)	1950	77.918	73.530	--	3.693	--
	1960	73.435	60.868	62.395	4.312	2.691
Yemen (1)	1950	98.125	--	--	--	--
	1960	96.600	--	--	--	--
<u>South Central Asia</u>						
Afghani- stan (1)	1950	94.217	--	--	--	--
	1960	93.752	--	--	--	--
Bhutan (1)	1950	100.000	--	--	--	--
	1960	100.000	--	--	--	--

Appendix Table V (continued)

Region and Country	Year	Rural Tot Pop x 100	ALF/TLF x 100	Farm/ Rural x 100	Rural/ ALF	Farm/ ALF
Ceylon (2)	1950	85.035	51.080	--	6.097	--
	1960	85.105	44.562	--	7.461	--
India (2)	1950	82.767	67.888	79.696	4.716	3.758
	1960	82.092	67.290	73.798	4.670	3.299
Nepal (1)	1950	97.600	91.538	--	3.771	--
	1960	97.211	91.712	--	3.839	--
Pakistan, East (1)	1950	95.748	82.756	--	4.393	--
	1960	94.891	83.330	--	4.355	--
Pakistan, West (2)	1950	82.727	65.432	--	4.725	--
	1960	77.948	57.936	--	5.296	--
Sikkim (1)	1950	98.015	--	--	--	--
	1960	95.750	--	--	--	--
<u>Northern Europe</u>						
Denmark (4)	1950	32.679	28.466	72.480	3.624	2.627
	1960	25.911	23.220	71.886	3.536	2.542
Finland (4)	1950	58.486	45.951	71.650	4.373	3.133
	1960	44.062	37.266	72.506	4.277	3.101
Iceland (4)	1950	39.021	34.000	51.971	3.647	1.895
	1960	33.523	--	--	--	--
Ireland (4)	1950	59.414	47.530	64.858	3.900	2.530
	1960	54.270	43.161	64.213	4.283	2.750
Norway (4)	1950	57.792	21.132	37.625	8.460	3.183
	1960	51.267	23.963	29.766	7.081	2.108
Sweden (4)	1950	44.561	25.261	52.486	5.410	2.840
	1960	39.026	17.603	31.590	7.294	2.304
United Kingdom (4)	1950	22.501	7.408	26.959	9.877	2.663
	1960	21.696	5.894	18.923	11.693	2.213
<u>Western Europe</u>						
Austria (4)	1950	50.988	26.026	44.188	6.593	2.913
	1960	49.972	18.436	32.794	9.483	3.110
Belgium (4)	1950	36.613	12.486	35.283	9.516	3.357
	1960	33.825	8.754	33.269	13.669	4.547
France (4)	1950	45.855	30.331	56.352	5.179	2.919
	1960	38.652	21.559	44.843	6.302	2.826
Germany, Fed Rep. (4)	1950	27.490	16.396	67.374	6.027	4.060
	1960	22.395	10.099	42.652	7.396	3.155

Appendix Table V (continued)

Region and Country	Year	Rural Tot Pop x 100	ALF/TLF x 100	Farm/ Rural x 100	Rural/ ALF	Farm/ ALF
Nether- lands (4)	1950	29.504	17.375	47.084	5.744	2.705
	1960	32.455	12.620	38.008	9.140	3.474
Switzer- land (4)	1950	51.835	21.980	34.153	7.339	2.507
	1960	45.828	14.977	27.303	9.460	2.583
<u>Eastern Europe</u>						
Bulgaria (3)	1950	72.597	--	--	--	--
	1960	62.794	--	--	--	--
Czechoslo- vakia (4)	1950	57.927	31.474	--	6.364	--
	1960	52.842	--	--	--	--
Germany, Dem Rep. (4)	1950	29.160	19.116	--	6.177	--
	1960	22.064	17.251	--	4.927	--
Hungary (4)	1950	63.247	40.011	--	4.923	--
	1960	60.265	30.616	59.687	6.195	3.698
Poland (4)	1950	60.976	48.046	77.244	4.628	3.575
	1960	52.290	38.811	73.436	5.174	3.800
Romania (3)	1950	74.428	--	--	--	--
	1960	67.875	--	--	--	--
<u>Southern Europe</u>						
Albania (2)	1950	79.491	--	--	--	--
	1960	69.127	55.841	84.164	4.703	3.958
Greece (3)	1950	48.994	48.936	81.405	3.367	2.741
	1960	43.005	47.847	81.151	3.175	2.576
Italy (4)	1950	56.048	40.270	66.133	4.289	2.837
	1960	52.230	28.119	48.620	6.186	3.008
Portugal (3)	1950	68.783	51.284	60.524	4.615	2.793
	1960	66.138	47.984	63.667	4.749	3.023
Spain (3)	1950	51.253	53.148	92.405	2.970	2.744
	1960	46.088	44.860	87.745	3.286	2.883
Yugoslavia (3)	1950	82.803	61.125	79.217	4.946	3.918
	1960	72.845	50.756	70.328	5.068	3.564
<u>Australia-New Zealand</u>						
Australia (4)	1950	27.855	16.886	41.870	5.232	2.191
	1960	19.022	13.916	51.721	4.577	2.367
New Zealand (4)	1950	39.256	23.209	49.800	5.766	2.871
	1960	36.594	18.328	40.795	7.185	2.931

Appendix Table V (continued)

<u>Region and Country</u>	<u>Year</u>	<u>Rural Tot Pop x 100</u>	<u>ALF/TLF x 100</u>	<u>Farm/ Rural x 100</u>	<u>Rural/ ALF</u>	<u>Farm/ ALF</u>
<u>Oceania</u>						
Fiji Is. (2)	1950	82,768	54.034	39,298	5.412	2.127
	1960	81,599	64.680	--	5.385	--
New Cale- donia (3)	1950	76,032	--	--	--	--
	1960	60,897	36.058	48,632	6.333	3.080
New Guinea (2)	1950	100,000	--	--	--	--
	1960	100,000	--	--	--	--
New Hebrides (1)	1950	100,000	--	97,959	--	--
	1960	100,000	--	--	--	--
Papua Is. (2)	1950	96,836	--	--	--	--
	1960	97,157	--	--	--	--
Solomon Is.- U.K. (1)	1950	97,800	--	100,204	--	--
	1960	96,935	--	--	--	--
<u>U.S.S.R.</u>						
U.S.S.R. (4)	1950	57,512	--	86,915	--	--
	1960	49,898	33.681	73,167	5.952	4.355

Appendix Table VI

INTERRELATIONSHIPS BETWEEN DIFFERENT TYPES
OF AGRICULTURAL LANDS: 1950 AND 1960

(Ratios are expressed in percentages)

Region and Country ^a	Year	Agr/ Tot Area	Arable/ Tot Area	Fallow/ Arable	Cult Past/ Arable	Cult Past/ Tot Past
<u>Northern Africa</u>						
Algeria (2)	1960	5.527	2.901	42.524	--	--
Libya (2)	1960	2.063	1.382	52.955	3.225	6.538
Morocco (2)	1950	--	20.022	37.913	--	--
	1960	--	19.243	--	--	--
Tunisia (2)	1950	--	30.380	43.518	2.630	--
	1960	64.707	35.948	--	2.222	2.778
U.A.R. (2)	1950	--	2.354	--	--	--
	1960	--	2.446	--	--	--
<u>Western Africa</u>						
Dahomey (1)	1960	17.173	13.355	61.449	--	--
Gambia (1)	1950	44.464	25.733	--	--	--
	1960	--	21.132	--	--	--
Ghana (2)	1950	--	17.914	--	--	--
	1960	--	24.123	--	--	--
Liberia (2)	1950	18.750	16.457	--	--	--
	1960	19.479	17.183	--	--	--
Mauritania (2)	1960	36.391	0.242	--	--	--
Niger (1)	1960	14.128	11.839	56.667	--	--
Nigeria (1)	1950	24.508	23.574	56.653	--	--
	1960	--	24.811	--	--	--
Port. Guinea (1)	1960	--	7.281	--	--	--
Senegal (2)	1960	--	28.034	58.878	--	--
Sierra Leone (1)	1950	86.646	55.959	--	--	--
	1960	82.384	52.469	98.581	--	--

^aCountries for which there are no agricultural land data for either 1950 or 1960 are not included in this table. Countries having data for only one of these years have a one-line entry only. For a list of those countries not included in the table, by subregions, see the last page of the table.

Appendix Table VI (continued)

Region and Country	Year	Agr/ Tot Area	Arable/ Tot Area	Fallow/ Arable	Cult Past/ Arable	Cult Past/ Tot Past
Togo (1)	1950	40,636	37,102	71,429	--	--
	1960	38,339	34,806	65,990	--	--
Upper Volta (1)	1960	--	17,870	--	--	--
<u>Eastern Africa</u>						
Ethiopia (1)	1950	59,283	9,544	--	--	--
	1960	59,284	9,684	--	--	--
Kenya (2)	1960	9,634	2,866	6,024	--	--
Madagascar (1)	1950	64,811	2,099	--	--	--
	1960	65,076	2,364	--	--	--
Malawi (1)	1950	34,833	29,005	--	--	--
	1960	37,280	30,975	--	--	--
Mozambique (2)	1950	--	3,739	--	--	--
	1960	--	4,486	--	--	--
Rwanda (1)	1950	74,728	41,425	--	--	--
	1960	71,109	39,118	--	--	--
Somalia (1)	1960	--	1,501	--	--	--
Tanganyika (1)	1960	17,633	8,298	--	--	--
Uganda (2)	1950	--	11,665	--	--	--
	1960	--	11,992	--	--	--
<u>Middle and Southern Africa</u>						
Botswana (1)	1960	57,455	0,727	--	150,000	1,923
Cameroon (2)	1950	32,619	14,100	74,554	--	--
Central Afr. Rep. (1)	1960	--	2,729	64,706	--	--
Chad (1)	1960	4,050	0,545	--	--	--
Congo	1950	21,667	20,697	--	--	--
Republic (2)	1960	21,957	20,911	--	--	--
Gabon (2)	1960	--	0,476	--	--	--
Lesotho (1)	1950	--	12,612	21,845	--	--
	1960	--	11,623	8,619	--	--
Southwest Africa (3)	1960	64,961	0,778	--	0,655	0,008

Appendix Table VI (continued)

Region and Country	Year	Agr/ Tot Area	Arable/ Tot Area	Fallow/ Arable	Cult Past/ Arable	Cult Past/ Tot Past
Sp. Eq. Guinea (1)	1960	11,586	7,879	--	--	--
Swaziland (1)	1950	84,221	5,162	--	--	--
	1960	93,764	8,199	--	--	--
<u>South Africa</u>						
South Africa (4)	1950	72,471	6,263	--	--	--
	1960	83,740	9,856	--	1,742	0,232
<u>Northern America</u>						
Canada (4)	1950	--	3,417	26,153	11,876	--
	1960	--	3,678	31,152	11,303	--
U.S.A. (4)	1950	38,761	17,548	14,308	17,012	14,073
	1960	39,287	16,117	17,329	17,412	12,112
<u>Middle America</u>						
Br. Hon- duras (2)	1950	1,633	1,324	--	--	--
	1960	1,929	1,341	--	--	--
Costa Rica (3)	1950	19,367	7,016	24,571	70,425	40,003
	1960	27,609	10,751	29,151	66,263	42,260
El Salvador (2)	1950	58,486	25,443	--	32,133	24,742
	1960	58,692	30,071	--	17,224	18,096
Guatemala (2)	1950	19,051	13,656	25,192	--	--
Honduras (2)	1950	14,697	7,556	47,421	--	--
	1960	32,960	8,655	--	--	--
Mexico (3)	1950	44,219	10,103	45,692	--	--
	1960	52,171	12,074	43,825	--	--
Nicaragua (2)	1950	--	3,852	21,730	110,006	--
	1960	18,721	6,118	35,743	123,334	59,879
Panama (3)	1950	13,249	5,951	47,446	94,980	77,450
	1960	18,094	7,280	40,439	124,115	83,547
<u>Caribbean</u>						
Bahama Is. (3)	1960	1,228	1,140	--	--	--
Cuba (3)	1950	--	17,522	--	--	--
	1960	32,680	18,313	--	--	--
Dominican Rep. (2)	1950	35,540	17,507	28,012	71,285	69,208
	1960	39,691	21,903	31,478	56,211	69,212
Haiti (1)	1950	31,351	13,333	--	--	--
Jamaica (3)	1950	42,454	23,153	--	--	--
	1960	36,699	19,624	--	29,684	34,118

Appendix Table VI (continued)

Region and Country	Year	Agr/ Tot Area	Arable/ Tot Area	Fallow/ Arable	Cult Past/ Arable	Cult Past/ Tot Past
Puerto Rico (4)	1950	69.079	33.967	--	--	--
	1960	63.932	31.988	--	--	--
Trinidad & Tobago (3)	1950	25.614	24.444	--	--	--
	1960	35.088	34.113	--	--	--
<u>Tropical South America</u>						
Brazil (3)	1950	14.888	2.243	--	78.413	13.911
	1960	17.745	3.373	--	69.877	16.400
Colombia (3)	1950	17.026	5.906	--	--	--
	1960	17.265	4.434	31.285	--	--
Fr. Guiana (2)	1950	0.582	0.033	--	--	--
	1960	0.582	0.033	--	--	--
Guyana (3)	1950	12.360	0.437	--	--	--
Peru (3)	1960	9.895	2.848	47.164	6.472	2.616
Surinam (3)	1950	0.238	0.231	--	--	--
	1960	0.322	0.279	--	--	--
Venezuela (3)	1950	18.117	2.960	47.172	61.669	12.006
	1960	20.763	2.733	--	106.270	16.109
<u>Temperate South America</u>						
Argentina (3)	1950	47.131	8.666	--	--	--
	1960	49.626	7.013	--	40.650	6.690
Chile (3)	1950	18.485	4.117	52.431	33.117	9.489
	1960	19.057	4.256	52.203	33.001	9.489
Falkland Is. (1)	1950	86.615	--	--	--	--
	1960	86.615	--	--	--	--
Paraguay (2)	1950	--	1.073	34.609	171.144	--
	1960	--	1.569	24.060	100.690	--
Uruguay (3)	1950	85.621	8.382	13.524	29.313	3.181
	1960	85.802	8.472	24.072	37.629	4.122
<u>East Asia</u>						
Taiwan (3)	1950	--	24.096	--	--	--
	1960	28.935	28.629	--	0.340	31.818
China (2)	1950	29.224	10.281	--	--	--
	1960	--	12.079	--	--	--
Korea, North (4)	1960	--	15.475	--	--	--
Korea, South (2)	1960	19.353	19.172	--	--	--

Appendix Table VI (continued)

Region and Country	Year	Agr/ Tot Area	Arable/ Tot Area	Fallow/ Arable	Cult Past/ Arable	Cult Past/ Tot Past
Mongolia (2)	1950	--	0.378	--	--	--
	1960	--	1.696	--	--	--
<u>Japan</u>						
Japan (4)	1950	15.974	14.152	--	--	--
	1960	18.069	16.356	--	--	--
<u>Southeast Asia</u>						
Burma (1)	1950	--	8.204	--	--	--
	1960	--	9.115	--	--	--
Cambodia (1)	1960	--	13.640	--	--	--
Indonesia (1)	1960	--	9.077	--	--	--
Laos (1)	1960	8.024	4.223	--	--	--
Malaya (2)	1950	14.519	--	--	--	--
	1960	--	13.467	--	--	--
Philip- pines (2)	1950	--	16.376	18.009	9.212	--
	1960	--	22.354	16.659	5.628	--
Sabah (2)	1960	2.153	2.085	--	--	--
Sarawak (2)	1950	--	26.910	--	--	--
	1960	--	23.793	--	--	--
Thailand (2)	1960	19.207	19.032	6.845	--	--
Vietnam, South (1)	1960	--	13.500	--	--	--
<u>Southwest Asia</u>						
Cyprus (3)	1950	--	39.628	38.898	--	--
	1960	49.919	39.866	38.666	--	--
Iran (2)	1960	7.567	6.789	40.524	1.175	10.261
Iraq (2)	1950	13.062	12.531	51.277	--	--
	1960	17.341	17.177	44.423	--	--
Israel (4)	1950	--	16.937	4.621	--	--
	1960	--	19.903	3.471	--	--
Jordan (1)	1950	--	8.604	--	--	--
	1960	11.209	10.186	--	--	--
Lebanon (2)	1950	--	27.596	--	--	--
	1960	--	31.346	--	--	--
Syria (2)	1960	67.858	32.477	42.135	--	--

Appendix Table VI (continued)

Region and Country	Year	Agr/ Tot Area	Arable/ Tot Area	Fallow/ Arable	Cult Past/ Arable	Cult Past/ Tot Past
Turkey (2)	1950	--	19,590	--	--	--
	1960	20,960	19,994	32,014	0,545	11,276
<u>South Central Asia</u>						
Afghani- stan (1)	1960	8,185	--	--	--	--
Ceylon (2)	1950	--	23,708	--	--	--
	1960	--	25,783	--	--	--
India (2)	1950	50,096	47,651	19,026	--	--
	1960	53,542	49,256	14,322	--	--
Nepal (1)	1960	--	13,005	--	--	--
Pakistan, East (1)	1950	--	56,248	1,462	--	--
	1960	--	57,079	1,441	--	--
Pakistan, West (2)	1950	--	17,145	15,255	--	--
	1960	--	18,775	14,044	--	--
<u>Northern Europe</u>						
Denmark (4)	1950	72,976	62,377	0,328	14,005	82,420
	1960	71,889	63,917	0,131	10,134	81,259
Finland (4)	1950	8,095	7,254	3,190	2,822	24,356
	1960	8,742	7,919	2,124	4,961	47,729
Ireland (4)	1950	--	22,332	--	197,400	--
	1960	--	21,017	--	206,838	--
Norway (4)	1950	4,760	2,514	0,467	65,660	73,454
	1960	4,654	2,630	1,115	56,455	73,368
Sweden (4)	1950	9,835	8,178	4,524	5,207	25,698
	1960	8,681	7,498	8,090	4,884	30,959
United Kingdom (4)	1950	79,860	21,146	2,110	143,526	51,692
	1960	81,388	18,544	1,726	175,236	51,710
<u>Western Europe</u>						
Austria (4)	1950	48,865	21,350	0,961	59,926	46,600
	1960	45,658	19,813	1,300	61,909	47,460
Belgium (4)	1950	56,598	33,773	--	17,285	25,574
	1960	54,192	29,525	0,477	21,370	25,578
France (4)	1950	61,354	38,907	--	22,798	39,515
	1960	63,399	39,521	--	20,223	33,471

Appendix Table VI (continued)

Region and Country	Year	Agr/ Tot Area	Arable/ Tot Area	Fallow/ Arable	Cult Past/ Arable	Cult Past/ Tot Past
Germany, Fed Rep. (4)	1950	57.099	34.539	--	42.476	65.034
	1960	57.684	34.576	--	42.784	64.014
Nether- lands (4)	1950	70.612	31.426	0.407	--	--
	1960	69.535	30.117	0.188	--	--
Switzer- land (4)	1950	52.945	11.844	--	--	--
	1960	52.437	10.608	--	--	--
<u>Eastern Europe</u>						
Bulgaria (3)	1950	51.565	41.145	--	6.495	25.598
	1960	51.140	41.692	--	5.554	24.506
Czechoslo- vakia (4)	1950	56.456	40.072	--	--	--
	1960	55.244	40.385	--	--	--
Germany, Dem Rep. (4)	1950	61.454	49.489	1.955	16.746	69.259
	1960	60.449	47.663	1.649	17.397	64.852
Hungary (4)	1950	79.350	63.091	2.058	--	--
	1960	76.760	61.303	2.234	--	--
Poland (4)	1950	--	52.183	--	25.589	--
	1960	--	52.042	--	25.763	--
Romania (3)	1950	60.312	41.219	2.414	17.184	37.097
	1960	61.249	43.562	0.846	13.402	33.010
<u>Southern Europe</u>						
Albania (2)	1950	41.979	13.608	--	--	--
	1960	42.633	16.213	--	--	--
Greece (3)	1950	--	23.341	24.830	--	--
	1960	34.371	27.431	13.439	--	--
Italy (4)	1950	68.394	51.307	--	--	--
	1960	68.641	51.771	--	--	--
Portugal (3)	1960	--	47.389	1.924	--	--
Spain (3)	1950	--	38.290	26.336	--	--
	1960	73.837	38.411	24.952	9.294	10.078
Yugoslavia (3)	1950	54.029	30.620	--	23.740	31.052
	1960	58.320	32.644	--	22.746	28.919
<u>Australia-New Zealand</u>						
Australia (4)	1950	48.840	1.480	30.242	64.682	2.021
	1960	60.438	1.688	21.923	103.853	2.983

Appendix Table VI (continued)

Region and Country	Year	Agr/ Tot Area	Arable/ Tot Area	Fallow/ Arable	Cult Past/ Arable	Cult Past/ Tot Past
New Zealand (4)	1950	48,376	1,559	8,763	1732.020	57.665
	1960	49,276	1,700	11,167	1625.400	58.071
<u>Oceania</u>						
Fiji Is. (2)	1950	11,187	7,640	--	--	--
	1960	11,805	8,237	--	9,701	22,393
New Caledonia (3)	1950	27,263	0,947	--	--	--
	1960	22,000	0,947	--	--	--
New Hebrides (1)	1950	--	3,522	--	--	--
Solomon Is.- U.K. (1)	1950	6,174	4,868	--	--	--
<u>U.S.S.R.</u>						
U.S.S.R. (4)	1950	--	7,510	13,043	--	--
	1960	26,839	10,149	10,714	--	--

NOTE: The following countries were not included in this table because agricultural land data were not available for them for either 1950 or 1960: Northern Africa--Spanish Sahara, Sudan; Western Africa--Guinea, Ivory Coast, Mali; Eastern Africa--Burundi, Fr. Somaliland, Somalia, South Rhodesia, Zambia; Middle and Southern Africa--Angola, Congo Brazzaville; Northern America--Greenland; Tropical South America--Bolivia, Ecuador; Southeast Asia--Port Timor, North Vietnam, West Irian; Southwest Asia--Fed. South Arabia, Kuwait, Muscat & Oman, Qatar, Saudi Arabia, Trucial Oman, Yemen; South Central Asia--Bhutan, Sikkim; Northern Europe--Iceland; Oceania--New Guinea, Papua Is.

Appendix Table VII

VARIOUS DENSITIES OF POPULATION PER SQUARE KILOMETER OF AREA:
1950 AND 1960

Region and Country	Tot Pop/ Tot Area	Rural Pop/Tot Area	Rural Pop/ Arable	ALF/ Arable	ALF/ Agr	Farm Pop/ Arable
<u>Northern Africa</u>						
Algeria (2)	3.745 4.528	2,829 3,115	-- 107,367	-- 22,763	-- 11,946	-- 96,041
Libya (2)	0.568 0.767	0,447 0,578	-- 41,833	-- --	-- --	-- 35,169
Morocco (2)	20,130 26,154	15,475 18,544	77,290 96,369	16,191 20,061	-- --	-- --
Spanish Sahara (1)	0.075 0.089	0,061 0,052	-- --	-- --	-- --	-- --
Sudan (1)	3,572 4,697	3,345 4,355	-- --	-- --	-- --	-- --
Tunisia (2)	28,399 33,208	19,708 20,914	64,870 58,178	12,937 13,522	-- 7,512	-- --
U.A.R. (2)	20,431 26,047	13,926 16,198	591,484 662,082	138,201 144,571	-- --	-- --
<u>Western Africa</u>						
Dahomey (1)	13,562 17,709	12,396 15,601	-- 116,818	-- --	-- --	-- --
Gambia (1)	25,367 28,742	23,553 26,283	91,529 124,372	-- --	-- --	-- --
Ghana (2)	20,311 28,201	17,423 21,699	97,257 89,950	-- 17,170	-- --	70,392 72,984
Guinea (2)	9,152 12,495	8,668 11,519	-- --	-- --	-- --	-- --
Ivory Coast (2)	8,020 10,017	7,409 8,432	-- --	-- --	-- --	-- --
Liberia (2)	7,722 8,871	7,342 7,722	44,615 44,939	-- 9,453	-- 8,339	-- --
Mali (1)	2,778 3,339	2,665 3,140	-- 318,837	-- --	-- --	-- 236,282
Mauritania (1)	0,656 0,893	0,642 0,873	-- 360,456	-- --	-- --	-- --
Niger (1)	1,660 2,270	1,622 2,210	-- 18,666	-- 4,447	-- 3,726	-- --

Appendix Table VII (continued)

Region and Country	Tot Pop/ Tot Area	Rural Pop/Tot Area	Rural Pop/ Arable	ALF/ Arable	ALF/ Agr	Farm Pop/ Arable
Nigeria (1)	34,720	30,167	127,969	28,210	27,134	--
	52,275	43,510	175,366	--	--	--
Port. Guinea (1)	14,120	12,702	--	--	--	--
	14,424	12,447	170,951	--	--	195,437
Senegal (2)	10,668	8,553	--	--	--	--
	15,852	12,131	43,273	11,127	--	34,436
Sierra Leone (1)	27,934	25,495	45,560	--	--	43,717
	31,057	27,572	52,549	10,372	6,506	52,650
Togo (1)	19,435	18,399	49,590	--	--	--
	25,442	22,986	66,041	13,655	12,396	66,396
Upper Volta (1)	13,220	12,863	--	--	--	--
	16,047	15,464	86,535	16,327	--	--
<u>Eastern Africa</u>						
Burundi (1)	66,897	66,250	--	--	--	--
	104,477	102,802	--	--	--	--
Ethiopia (1)	13,510	12,708	133,146	--	--	--
	17,478	16,381	169,146	--	--	156,625
Fr. Somali- land (2)	0,259	0,173	--	--	--	--
	0,369	0,202	--	--	--	--
Kenya (2)	10,329	9,793	--	--	--	--
	13,928	12,888	449,614	--	--	--
Madagascar (1)	7,214	6,571	312,989	--	--	--
	9,141	8,153	344,803	--	--	299,900
Malawi (1)	28,999	28,639	98,738	--	--	77,884
	36,937	35,968	116,121	--	--	95,374
Mozambique (2)	7,329	7,168	191,701	37,876	--	--
	8,402	8,095	180,547	--	--	130,444
Rwanda (1)	37,844	37,803	91,257	--	--	--
	49,271	49,188	125,743	--	--	--
Somalia (1)	2,958	2,486	--	--	--	--
	3,152	2,525	168,234	--	--	--
South Rhodesia (3)	6,810	6,153	--	--	--	--
	9,347	7,827	--	--	--	--
Tanganyika (1)	8,252	8,002	--	--	--	--
	9,857	9,394	113,215	--	--	--

Appendix Table VII (continued)

Region and Country	Tot Pop/ Tot Area	Rural Pop/Tot Area	Rural Pop/ Arable	ALF/ Arable	ALF/ Agr	Farm Pop/ Arable
Uganda (2)	21.359	20.940	179.510	--	--	--
	27.431	26.388	220.049	--	--	--
Zambia (3)	3.270	2,845	--	--	--	--
	4.301	3,484	--	--	--	--
<u>Middle and Southern Africa</u>						
Angola (2)	3.325	3,127	--	--	--	--
	3.875	3,561	--	--	--	--
Botswana (1)	0.518	0.413	--	--	--	--
	0.678	0.536	73.745	18,842	0.239	39,459
Cameroon (2)	8.834	8,380	59.428	--	--	--
	9.886	9,069	--	--	--	--
Central Afr. Rep. (1)	1.721	1,598	--	--	--	--
	1.974	1,705	62.471	--	--	55,000
Chad (1)	2.009	1,965	--	--	--	--
	2.391	2,290	420,143	--	--	--
Congo Brazza- ville (2)	1.974	1,655	--	--	--	--
	2.260	1,664	--	--	--	--
Congo Republic (2)	4.856	4,494	21,712	--	--	--
	6.028	5,155	24,653	--	--	--
Gabon (2)	1.566	1,461	--	--	--	--
	1.648	1,446	303,937	70,787	--	260,394
Lesotho (1)	22.075	21,931	173,892	--	--	--
	29.285	28,981	249,333	--	--	--
Southwest Africa (3)	0.510	0,434	--	--	--	--
	0.638	0,489	62,802	--	--	61,711
Sp. Eq. Guinea (1)	7.094	6,699	--	--	--	--
	8.770	7,936	100,724	--	--	--
Swaziland (1)	11.836	11,836	229,306	91,163	5,587	--
	15.589	14,754	179,952	--	--	--
<u>South Africa</u>						
South Africa (4)	10.183	6,197	98,960	18,180	1,571	--
	13.081	7,212	73,170	13,045	1,535	58,010
<u>Northern America</u>						
Canada (4)	1.377	0,527	15,420	2,885	--	8,557
	1.795	0,565	15,353	1,937	--	5,828

Appendix Table VII (continued)

Region and Country	Tot Pop/ Tot Area	Rural Pop/Tot Area	Rural Pop/ Arable	ALF/ Arable	ALF/ Agr	Farm Pop/ Arable
Greenland (4)	0.011 0.015	0.010 0.014	-- --	-- --	-- --	-- --
U.S.A. (4)	16.208 19.298	5.835 5.817	33.252 36.091	3.978 2.566	1,801 1,053	13.992 8.920
<u>Middle America</u>						
Br. Hondur- ras (2)	2.917 3.923	1.846 2.482	139.474 185.065	25.658 30.844	20,800 21,445	-- --
Costa Rica (3)	15.878 23.097	10.592 15.069	150.970 140.158	37.110 29.811	13,443 11,609	-- 111.392
El Salva- dor (2)	86.757 114.710	55.111 70.958	216.608 235.971	66.140 65.071	28,772 33,339	-- --
Guatemala (2)	25.631 34.989	19.240 24.254	140.888 --	37.794 --	27,091 --	116.207 --
Honduras (2)	12.543 16.840	10.321 13.194	136.588 152.457	30.787 32.648	15,829 8,573	-- --
Mexico (3)	13.075 17.704	7.507 8.729	74.306 72.293	19.801 21.896	4,524 5,068	-- --
Nicaragua (2)	8.131 10.854	5.292 6.585	137.408 107.619	43.539 31.934	-- 10,437	-- --
Panama (3)	10.641 14.223	6.808 8.328	114.394 114.400	25.766 25.622	11,573 10,228	91.515 86.617
<u>Caribbean</u>						
Bahama Is. (3)	6.930 10.351	4.263 5.561	-- 487.692	-- --	-- --	-- --
Cuba (3)	48.166 39.605	20.931 25.349	119.456 138.423	37.212 --	-- --	-- --
Dominican Rep. (2)	43.830 62.236	33.406 43.399	190.811 198.145	50.867 46.468	25,058 25,642	115.448 --
Haiti (1)	111.604 143.820	98.018 122.595	735.135 --	204.865 --	87,126 --	-- --
Jamaica (3)	119.214 142.271	92.052 100.699	397.586 513.129	-- 84.557	-- 45,217	379.668 338.674
Puerto Rico (4)	248.511 264.134	147.915 147.578	435.473 461.349	68.167 43.921	33,518 21,976	-- --
Trinidad & Tobago	123.197 161.404	91.228 97.466	373.206 285.714	34.848 24.571	33,257 23,889	103.110 97.829

Appendix Table VII (continued)

Region and Country	Tot Pop/ Tot Area	Rural Pop/Tot Area	Rural Pop/ Arable	ALF/ Arable	ALF/ Agr	Farm Pop/ Arable
<u>Tropical South America</u>						
Bolivia (2)	2,748 3,143	2,187 2,426	-- --	-- --	-- --	-- --
Brazil (3)	6,112 8,345	3,905 4,586	174,071 135,963	43,498 33,254	6,554 6,321	-- --
Colombia (3)	9,534 13,392	5,945 6,834	100,659 154,133	27,280 40,897	9,464 10,503	91,396 129,896
Ecuador (2)	11,834 16,079	8,457 10,773	-- --	-- --	-- --	-- --
Fr. Guiana (2)	0,275 0,363	0,152 0,179	460,000 543,333	-- 83,333	-- 4,717	-- --
Guyana (2)	1,968 2,605	1,419 1,851	324,468 --	51,489 --	1,822 --	-- --
Peru (3)	6,473 8,578	4,175 5,074	-- 178,150	-- 34,450	-- 9,916	-- --
Surinam (3)	1,463 1,911	0,963 1,223	416,667 438,693	-- --	-- --	-- 239,196
Venezuela (3)	5,583 8,058	3,060 3,027	103,374 110,763	20,816 26,738	3,401 3,520	73,558 96,285
<u>Temperate South America</u>						
Argentina (3)	6,148 7,205	2,258 2,379	26,056 33,926	6,183 6,902	1,137 0,975	16,661 21,306
Chile (3)	8,187 10,478	3,745 3,699	90,972 86,921	18,096 19,544	4,030 4,365	-- 52,900
Falkland Is. (1)	0,167 0,167	0,167 0,167	-- --	-- --	-- --	-- --
Paraguay (2)	3,307 4,305	2,218 2,825	206,738 180,094	47,215 41,818	-- --	179,693 146,254
Uruguay (3)	11,732 13,567	5,093 3,793	60,757 44,771	-- 10,577	-- 1,044	28,974 24,968
<u>East Asia</u>						
Taiwan (3)	211,874 295,106	101,279 122,358	420,312 427,392	146,913 129,480	-- 128,111	488,355 543,108
China (2)	57,371 68,640	51,051 57,282	496,542 474,211	-- --	-- --	403,277 385,122

Appendix Table VII (continued)

Region and Country	Tot Pop/ Tot Area	Rural Pop/Tot Area	Rural Pop/ Arable	ALF/ Arable	ALF/ Agr	Farm Pop/ Arable
Korea, North (4)	79.255 86.608	68.952 70.267	-- 454.065	-- --	-- --	-- --
Korea, South (2)	208.402 253.876	170.304 182.790	-- 953.421	-- 168.777	-- 167.200	-- 756.844
Mongolia (2)	4.677 6.089	3.751 3.962	991.554 233.522	-- --	-- --	-- --
<u>Japan</u>						
Japan (4)	225.664 252.716	141.254 129.895	998.089 794.168	164.825 113.344	146.031 102.599	722.743 571.367
<u>Southeast Asia</u>						
Burma (1)	27.677 32.970	24.101 28.251	293.776 309.931	-- --	-- --	-- --
Cambodia (1)	23.616 31.534	21.761 28.346	-- 207.820	-- 41.513	-- --	-- 149.286
Indonesia (1)	50.953 62.690	44.693 53.328	-- 587.520	-- 121.059	-- --	-- --
Laos (1)	5.574 9.840	5.212 8.995	-- 213.000	-- --	-- --	-- --
Malaya (2)	39.531 52.624	29.911 34.268	-- 254.454	-- 45.190	45.499 --	-- 156.686
Philippines (2)	67.655 90.389	54.211 70.962	331.044 317.450	59.804 61.666	-- --	266.368 181.221
Port. Timor (1)	29.615 34.640	26.693 31.142	-- --	-- --	-- --	-- --
Sabah (2)	4.336 5.965	3.761 5.075	-- 243.415	-- 56.081	-- 54.301	-- 146.125
Sarawak (2)	4.672 5.990	4.136 5.096	15.368 21.417	-- 4.565	-- --	-- 16.046
Thailand (2)	38.200 51.086	34.370 45.241	-- 237.717	-- 52.381	-- 51.902	-- 200.262
Vietnam, North (1)	75.591 101.417	69.726 86.998	-- --	-- --	-- --	-- --
Vietnam, South (1)	61.472 82.548	51.513 65.312	-- 483.802	-- --	-- --	-- 435.101
West Irian (1)	1.696 1.696	1.664 1.662	-- --	-- --	-- --	-- --

Appendix Table VII (continued)

Region and Country	Tot Pop/ Tot Area	Rural Pop/Tot Area	Rural Pop/ Arable	ALF/ Arable	ALF/ Agr	Farm Pop/ Arable
<u>Southwest Asia</u>						
Cyprus (3)	53.400 62.047	40.428 39.779	102,019 99,783	13.775 11.659	-- 9.311	68,194 64,805
Fed. South Arabia (1)	2.419 2.680	1.964 1.929	-- --	-- --	-- --	-- --
Iran (2)	9.876 13.046	7.238 8.751	-- 128,887	-- 31.209	-- 28.002	-- 108,107
Iraq (2)	11.910 15.706	7.755 9.544	61,888 55,564	-- 10.762	-- 10.661	-- --
Israel (4)	60.773 102.126	12.271 23.043	72,447 115,777	21.791 18.883	-- --	64,461 67,718
Jordan (1)	13.198 17.342	8.625 10.518	100,238 103,254	-- 12.415	-- 11.281	-- --
Kuwait (4)	10.625 17.375	4.500 5.188	-- --	-- --	-- --	-- --
Lebanon (2)	170.481 202.885	125.288 135.769	454,007 433,129	-- --	-- --	-- --
Muscat & Oman (1)	2.590 2.660	2.528 2.566	-- --	-- --	-- --	-- --
Qatar (1)	0.909 2.044	0.454 0.818	-- --	-- --	-- --	-- --
Saudi Arabia (1)	2.442 2.884	2.210 2.419	-- --	-- --	-- --	-- --
Syria (2)	18.587 24.630	12.021 15.531	-- 47,822	-- 7.133	-- 3.414	-- 42,750
Trucial Oman (1)	0.957 1.196	0.718 0.718	-- --	-- --	-- --	-- --
Turkey (2)	26.647 35.243	20.763 25.881	105,987 129,444	28.702 30.019	-- 28.636	-- 80,766
Yemen (1)	20.513 25.641	20.128 24.769	-- --	-- --	-- --	-- --
<u>South Central Asia</u>						
Afghanistan (1)	18.533 22.147	17.461 20.763	-- --	-- --	-- --	-- --
Bhutan (1)	11.426 14.489	11.426 14.489	-- --	-- --	-- --	-- --

Appendix Table VII (continued)

Region and Country	Tot Pop/ Tot Area	Rural Pop/Tot Area	Rural Pop/ Arable	ALF/ Arable	ALF/ Agr	Farm Pop/ Arable
Ceylon (2)	117,025 150,831	99,512 128,365	419,736 497,872	68,846 66,730	-- --	-- --
India (2)	108,306 131,743	89,642 108,151	188,121 219,568	39,892 49,120	37,945 45,188	149,925 162,036
Nepal (1)	56,819 65,200	55,456 63,382	-- 487,384	-- 126,969	-- --	-- --
Pakistan, East (1)	288,088 349,288	275,838 331,442	490,393 580,674	111,643 133,346	-- --	-- --
Pakistan, West (2)	40,974 52,074	33,897 40,590	197,703 216,196	41,845 40,820	-- --	-- --
Sikkim (1)	1,914 2,251	1,876 2,156	-- --	-- --	-- --	-- --
<u>Northern Europe</u>						
Denmark (4)	99,466 106,529	32,505 27,602	52,110 43,184	14,378 12,214	12,289 10,859	37,770 31,043
Finland (4)	11,958 13,192	6,994 5,813	96,409 73,401	22,047 17,161	19,757 15,545	69,077 53,220
Iceland (4)	1,382 1,700	0,539 0,570	-- --	-- --	-- --	-- --
Ireland (4)	42,245 40,324	25,100 21,884	112,392 104,123	28,818 24,311	-- --	72,896 66,861
Norway (4)	10,123 11,086	5,850 5,684	232,744 216,080	27,512 30,516	14,527 17,246	87,571 64,319
Sweden (4)	15,658 16,666	6,978 6,504	85,323 86,741	15,770 11,892	13,113 10,271	44,782 27,401
United Kingdom (4)	207,426 215,388	46,672 46,730	220,713 251,989	22,346 21,550	5,917 4,910	59,503 47,684
<u>Western Europe</u>						
Austria (4)	82,707 84,055	42,171 42,004	197,520 212,003	29,958 22,356	13,089 9,701	87,281 69,524
Belgium (4)	283,153 300,000	103,671 101,475	306,968 343,694	32,259 25,144	19,249 13,699	108,307 114,343
France (4)	76,296 83,513	34,986 32,280	89,922 81,678	17,362 12,960	11,010 8,079	50,672 36,627
Germany, Fed. Rep. (4)	205,663 224,494	56,538 50,275	163,690 145,408	27,160 19,659	16,430 11,784	110,284 62,020

Appendix Table VII (continued)

Region and Country	Tot Pop/ Tot Area	Rural Pop/Tot Area	Rural Pop/ Arable	ALF/ Arable	ALF/ Agr	Farm Pop/ Arable
Netherlands	300,904	88,778	282,496	49,181	21,888	133,011
(4)	341,009	110,675	367,480	40,205	17,414	139,672
Switzerland	114,198	59,194	499,796	68,098	15,233	170,695
(4)	131,491	60,260	568,037	60,046	12,148	155,091
<u>Eastern Europe</u>						
Bulgaria (3)	65,376	47,461	115,350	--	--	--
	70,930	44,540	106,832	--	--	--
Czechoslovakia	96,489	55,893	139,481	21,916	15,556	--
(4)	106,781	56,425	139,717	--	--	--
Germany, Dem.	170,415	49,694	100,414	16,257	13,092	--
Rep. (4)	159,785	35,255	73,966	15,011	11,836	--
Hungary (4)	100,376	63,485	100,624	20,438	16,251	--
	107,073	64,528	105,260	16,991	13,570	62,827
Poland (4)	80,223	48,917	93,743	20,256	--	72,411
	95,519	49,947	95,974	18,548	--	70,479
Romania	68,678	51,116	124,012	--	--	--
	77,486	52,594	120,733	--	--	--
<u>Southern Europe</u>						
Albania (2)	42,403	33,707	247,699	--	--	--
	56,560	39,098	241,150	51,277	19,501	202,961
Greece (3)	57,252	28,050	120,174	35,689	--	97,828
	63,110	27,140	98,942	31,166	24,873	80,292
Italy (4)	155,263	87,021	169,610	39,542	29,663	112,168
	164,800	86,075	166,263	26,875	20,270	80,838
Portugal (3)	94,992	65,339	--	--	--	--
	100,034	66,160	139,611	29,399	--	88,886
Spain (3)	55,428	28,408	74,192	24,981	--	68,557
	60,289	27,786	72,339	22,014	11,452	63,474
Yugoslavia	63,882	52,896	172,750	34,930	19,796	136,847
(3)	71,917	52,388	160,481	31,665	17,724	112,864
<u>Australia-New Zealand</u>						
Australia (4)	1,074	0,299	20,223	3,865	0,117	8,467
	1,351	0,257	15,233	3,328	0,093	7,879
New Zealand (4)	7,101	2,788	178,844	31,017	0,999	89,064
	8,828	3,231	190,059	26,451	0,912	77,534

Appendix Table VII (continued)

<u>Region and Country</u>	<u>Tot Pop/ Tot Area</u>	<u>Rural Pop/Tot Area</u>	<u>Rural Pop/ Arable</u>	<u>ALF/ Arable</u>	<u>ALF/ Agr</u>	<u>Farm Pop/ Arable</u>
<u>Oceania</u>						
Fiji Is. (2)	15.817 21.563	13.091 17.595	171.347 213.621	31.662 39.668	21.624 27.677	67.335 --
New Caledonia (3)	3.316 4.105	2.521 2.500	266.111 263.889	-- 41.667	-- 1.794	-- 128.333
New Guinea (2)	4.525 5.874	4.525 5.874	-- --	-- --	-- --	-- --
New Hebrides (1)	3.319 4.064	3.319 4.064	96.231 --	-- --	-- --	92.308 --
Papua Is. (2)	1.673 2.256	1.620 2.191	-- --	-- --	-- --	-- --
Solomon Is.-- U.K. (1)	3.357 4.163	3.284 4.036	67.448 --	-- --	-- --	67.586 --
<u>U.S.S.R.</u>						
U.S.S.R. (4)	8.037 9.570	4.622 4.776	61.547 47.054	-- 7.905	-- 2.989	53.493 34.428

BIBLIOGRAPHY

- Adelman, Irma, and Thorbecke, Erik. The Theory and Design of Economic Development. Baltimore: John Hopkins University Press, 1966.
- Agarwala, A.N., and Singh, S.P., eds. The Economics of Underdevelopment. New York: Oxford University Press, 1958.
- Amin, Galal A. Food Supply and Economic Development. New York: Augustus M. Kelley, 1966.
- Aron, Raymond. Progress and Disillusion: The Dialectics of Modern Society. New York: Frederick A. Praeger, 1968.
- Arriaga, Eduardo E., and Davis, Kingsley. "The Pattern of Mortality Change in Latin America," Demography, Vol. VI, No. 3 (August 1969).
- Bairoch, Paul. Diagnostic de l'évolution économique du Tiers-monde, 1900-1966. Paris: Gauthier-Villas, 1967.
- _____, et al. La Population active et la structure: Statistiques internationales retrospectives. Bruxelles: Editions de l'Institut de Sociologie, Université Libre de Bruxelles, 1968.
- _____, and Limbor, J.M. "Changes in the Industrial Distribution of the World Labor Force by Region, 1860-1960," International Labor Review, Vol. XCVIII, No. 4 (October 1968).
- Bancroft, Gertrude. The American Labor Force. New York: John Wiley and Sons, Inc., 1958.
- Barbour, Kenneth M., and Prothero, R.M., eds. Essays on African Population. London: Routledge and Kegan Paul, 1961.
- Barlowe, Raleigh. Land Resource Economics. Englewood Cliffs: Prentice-Hall, Inc., 1958.
- Baumol, William J. Economic Dynamics. New York: The Macmillan Company, 1951.
- Beau-Garnier, J. Geography of Population. London: Longmans, Green and Company, Ltd., 1966.
- Best, Robin H., and Coppock, J.T. The Changing Use of Land in Britain. London: Faber and Faber, 1962.
- Black, Michael. "Agriculture Labor in Explaining Economy," Journal of Agricultural Economics (London), January 1968.
- Bogue, Donald. Principles of Demography. New York: John Wiley and Sons, Inc., 1969.

BIBLIOGRAPHY

- Böker, Hugo. "The Decline of the Population Occupied in Agriculture, Its Causes and Its Economic and Social Effects," Monthly Bulletin of Agriculture Economics and Sociology, International Review of Agriculture, Vol. XXXIII, No. 12 (December 1942).
- Boserup, Ester. The Conditions of Agricultural Growth. Chicago: Aldine Publishing Company, 1965.
- Browder, Gordon. "Agriculture Depopulation in Eight Montana Counties," Montana Business Quarterly, Vol. I, No. 3 (Spring 1963).
- Brown, Lester R. An Economic Analysis of Far Eastern Agriculture. U.S. Department of Agriculture: Foreign Agriculture Economic Report No. 2, 1961.
- Budouin, Robert. "Pression démographique et développement agricole en Afrique," Revue de Droit des Pays Afrique, 76 (713-714), December 1960.
- Cain, Glen G. Married Women in the Labor Force. Chicago: University of Chicago Press, 1966.
- Caldwell, John C. African Rural-Urban Migration: The Movements to Ghana's Towns. Canberra: Australian National University Press, 1969.
- Campbell, Keith O. "Rural Population in Relation to Economic Development" in International Conference on Agriculture Economics, Proceedings, 1958. London: Oxford University Press, 1959.
- Carver, T.N. "Rural Depopulation," Journal of Farm Economics, Vol. IX, No. 1 (January 1927).
- Chang, Pei-kang. Agriculture and Industrialization: The Adjustments that Take Place as an Agricultural Country is Industrialized. Cambridge: Harvard University Press, Harvard Economic Studies, Vol. 85, 1949.
- Chao, Kuo-chun. Agrarian Policy of the Chinese Communist Party 1921-1959. Bombay: Asia Publishing House, 1960.
- Chauhan, D.S. Studies in Utilization of Agricultural Land. Agra: Shiv Lal Agarwala and Company, 1966.
- Christian, C.S. "The Use and Abuse of Land and Water" in Larry K.Y. Ng, ed., The Population Crisis. Bloomington: Indiana University Press, 1965.
- Cipolla, Carlo M. The Economic History of World Population. Baltimore: Penguin Books, 1962.
- Clark, Colin. Population Growth and Land Use. London: Macmillan and Company, Ltd., 1967.
- _____, and Haswell, Margaret. The Economics of Subsistence Agriculture. London: St. Martin's Press, 1964.

BIBLIOGRAPHY

- Coale, Ansley J., and Hoover, Edgar M. Population Growth and Economic Development in Low Income Countries. Princeton: Princeton University Press, 1958.
- Cochrane, Willard W. The World Food Problem: A Guardedly Optimistic View. New York: Thomas Y. Crowell, 1969.
- Cohen, R.L. The Economics of Agriculture. London: Nisbet and Company, Ltd., 1940.
- Conklin, H. Hanunoo Agriculture in the Philippines. Rome: Food and Agriculture Organization of the United Nations, 1957.
- Conquest, Robert, ed. Agriculture Workers in the U.S.S.R. New York: Frederick A. Praeger, 1969.
- Danish National F.A.O. Committee. Report from the Danish National F.A.O. Committee to the Food and Agriculture Organization of the United Nations. Denmark, 1950.
- Davis, Kingsley. Human Society. New York: The Macmillan Company, 1965.
- _____. World Urbanization 1950-1970, Volume I: Basic Data for Cities, Countries, and Regions. Berkeley: University of California, Institute of International Studies, 1969; Population Monograph Series, No. 4.
- _____. "Population and the Further Spread of Industrial Society" in Proceedings of the American Philosophical Society, Vol. XCV, No. 1 (1951).
- _____. "Problems and Solutions in International Comparisons for Social Science Purposes." Berkeley: University of California, 1968; Population Reprint Series No. 273.
- _____. "The Theory of Change and Response in Modern Demographic History," Population Index, Vol. XXIX, No. 4 (October 1963).
- Despois, J. "Development of Land Use in Northern Africa" in Stamp, ed. See Stamp.
- Dominion Bureau of Statistics. Census of Canada, 1966, Rural Farm, Rural Non-farm and Urban Population by Sex, 1961 and 1966. Volume I, Reports I-8.
- Dovring, Folke. Land and Labor in Europe in the Twentieth Century. The Hague: Martinus Nijhoff, 1965.
- _____. "The Share of Agriculture in a Growing Population" in Eicher and Witt, eds. See Eicher.
- Draper, N.R., and Smith, H. Applied Regression Analysis. New York: John Wiley and Sons, Inc., 1966.
- Economic Commission for Latin America. Energy in Latin America. Geneva: United Nations, Department of Economic and Social Affairs (E/CN.12/344/Rev. 1), 1957.

BIBLIOGRAPHY

- Edwards, John B. "The Relation between the F-test and $\bar{R}^2$," The American Statistician, Vol. XXIII, No. 5 (December 1969).
- Eicher, Carl, and Witt, Lawrence, eds. Agriculture in Economic Development. New York: McGraw-Hill, 1964.
- Elesh, David. "Methodological Inadequacies in Quantification of Case-Study Data," The American Sociologist, Vol. IV, No. 4 (November 1969).
- Elkan, W. "Circular Migration and Growth of Towns in East Africa," International Labor Review (Geneva), Vol. 96, 1967.
- Enke, Stephen. Economics for Development. Englewood Cliffs: Prentice-Hall, 1963.
- Erdei, Ferenc. "Some Questions of Density of Population and Trends in Agrarian Densities," Demografia (Budapest), Vol. II, No. 1 (1959). [With English summary.]
- Food and Agriculture Organization, and the European Association for Animal Production. Problems of Animal Feeding in Europe. Rome: F.A.O. Agricultural Development Paper No. 51, June 1955.
- Ganguli, B.N. "Population and Migration Factors in Rural Development" in Proceedings of the Twelfth International Conference of Agricultural Economists. London: Oxford University Press, 1966.
- Geertz, Clifford. Agricultural Involution: The Process of Ecological Change in Indonesia. Berkeley: University of California Press, 1963.
- Glass, D.V. "Population Growth and Population Policy" in Mindel C. Sheps and Jeanne C. Ridley, eds., Public Health and Population Change. Pittsburgh: University of Pittsburgh Press, 1965.
- Haitovsky, Yoel. "A Note on the Maximization of $\bar{R}^2$," The American Statistician, Vol. XXIII, No. 1 (February 1969).
- Hamdan, G. "Evolution of Irrigation Agriculture in Egypt" in Stamp, ed. See Stamp.
- Hance, William A. "The Race between Population and Resources," Africa Report, Vol. XIII, No. 1 (January 1968).
- Hathaway, Dale E. et al. People of Rural America. Washington, D.C.: U.S. Department of Commerce, Bureau of the Census, 1968.
- Hauser, Philip M., ed. Population and World Politics. New York: The Free Press of Glencoe, 1958.
- Heady, Earl O. A Primer on Food, Agriculture, and Public Policy. New York: Random House, 1967.
- _____, and Tweeten, Luther G. Resource Demand and Structure

BIBLIOGRAPHY

- of the Agriculture Industry. Ames: Iowa State University Press, 1963.
- Hicks, George L., and McNicoll, Geoffry. Foreign Trade and the Growth of the Dual Economy: A Study of the Philippines. Washington, D.C.: Center for Development Planning, National Planning Association, 1968.
- Higgins, Benjamin H. Economic Development: Principles, Problems, and Policies. New York: W.W. Norton, 1968.
- Hill, George W. "Reproduction and Replacement of Farm Population and Agriculture Policy," Journal of Farm Economics, Vol. XXIX, No. 2 (May 1947).
- Hong, Young-Pyo. "Agriculture Overpopulation in Korea," Journal of Population Studies (Seoul), No. 2, 1966.
- Holler, Joane E. Population Growth and Social Change in Middle East. Washington, D.C.: George Washington University Press, 1964.
- Indian Society of Agriculture Economics. Readings in Land Utilization. Bombay: Readings in Agriculture Economics Series, Vol. 5, 1957.
- _____. Indian Journal of Agriculture Economics: Special Issue on "The Role of Agriculture in Economic Development," 18, October 1961.
- _____. Indian Journal of Agriculture Economics: Conference Issue, 22, October-December 1967.
- _____. Journal of Agriculture Economics: Supplement to the Conference Number, October-December 1967, 23, January-March 1968.
- Johnson, B.L.C. "Rural Densities in East Pakistan," Pacific Viewpoint (Wellington), March 1962.
- Johnson, Sherman E. "President's Address" in Proceedings of the Eleventh International Conference of Agricultural Economists. London: Oxford University Press, 1963.
- Johnston, Bruce F. Agriculture and Economic Development in Japan: Its Relevance to the Developing Nations. Stanford: Food Research Institute Studies No. 6, Stanford University, 1966.
- _____, and Mellor, J.W. "The Role of Agriculture in Economic Development," The American Economic Review, Vol. LI, No. 4 (September 1961).
- Karcz, Jerzy F. Soviet and East European Agriculture. Berkeley: University of California Press, 1967.
- Keyfitz, Nathan. "The Impact of Technological Change on Demographic Patterns" in B.F. Hoselitz and W.E. Moore, eds., Industrialization and Society. UNESCO, Mouton, 1963.

BIBLIOGRAPHY

- _____. "Indonesian Population and the European Industrial Revolution," Asian Survey, Vol. V, No. 10 (1965).
- Krishnamurty, J. "Secular Changes in Occupational Structure: India 1881-1961," Indian Economic and Social History Review, Vol. II, No. 1 (January 1965).
- Kuhn, Thomas S. The Structure of Scientific Revolutions. Chicago: University of Chicago Press, 1962.
- Kuper, Hilda, ed. Urbanization and Migration in West Africa. Berkeley: University of California Press, 1965.
- Kuznets, Simon. Modern Economic Growth. New Haven: Yale University Press, Studies in Comparative Economics, No. 7, 1966.
- _____, et al., eds. Economic Growth: Brazil, India, Japan. Durham, N.C.: Duke University Press, 1955.
- _____. "Consumption, Industrialization, and Urbanization" in B.F. Hoselitz and W.E. Moore, Industrialization and Society. UNESCO, Mouton, 1963.
- Labovitz, Sanford. "Criteria for Selecting a Significance Level: A Note on the Sacredness of .05," The American Sociologist, Vol. III, No. 3 (August 1968).
- Leibenstein, Harvey. Economic Backwardness and Economic Growth. New York: John Wiley and Sons, Inc., 1957.
- _____. A Theory of Economic-Demographic Development. Princeton: Princeton University Press, 1954.
- Lockwood, William W. The Economic Development of Japan. Princeton: Princeton University Press, 1968.
- _____, ed. The State and Economic Enterprise in Japan. Princeton: Princeton University Press, 1965.
- Maalgi, S.S. "Hunger in Rural India 1960-61 to 1964-65," Economic and Political Weekly (Bombay), No. 112, 1968.
- Marsh, David C. The Changing Social Structure of England and Wales 1871-1951. London: Routledge and Kegan Paul, 1958.
- Mehra, D.S., and Bhatnagar, D.S. "A Study of Landless Population in Rural India," Indian Journal of Economics (Allahabad), Volume XLVII, No. 187 (April 1967).
- Mellor, John W. "Toward a Theory of Agricultural Development" in Southworth and Johnston, eds. See Southworth.
- Merritt, Richard L., and Rokkan, Stein, eds. Comparing Nations: The Use of Quantitative Data in Cross-National Research. New Haven: Yale University Press, 1966.
- Micklin, Michael. "Urban Life and Differential Fertility, Specification of an Aspect of the Theory of Demographic Transition," The Sociological Quarterly, Vol. X, No. 4 (Fall 1969).

BIBLIOGRAPHY

- Milbank Memorial Fund. The Interrelations of Demographic, Economic and Social Problems in Underdeveloped Areas. New York: Milbank Memorial Fund, 1954.
- Miracle, Marvin P. Agriculture in the Congo Basin. Madison: University of Wisconsin Press, 1967.
- Morris, A. "Postwar Development Trends in the Countryside in Economic and Social Respects" in Planning and Development in the Netherlands. The Hague, Volume 2, 1964.
- Myrdal, Alva. Nation and Family. London: Kegan Paul, Trench, Trubner and Company, Ltd., 1945.
- Myrdal, Gunnar. Asian Drama: An Inquiry into the Poverty of Nations, Vols. I-III. New York: Pantheon, 1968.
- National Bureau of Economic Research. Demographic and Economic Change in Developed Countries. Princeton: Princeton University Press, 1960.
- National Farm Institute. Farmers and a Hungry World. Ames: Iowa State University, 1967.
- Noziri, Shigeo. Internal Migration of Rural Population in Japan. Tokyo: Japanese National Committee for UNESCO, 1965.
- Ojala, E.M. Agriculture and Economic Progress. London: Oxford University Press, 1952.
- Oluwasanmi, H.A. Agriculture and Nigerian Economic Development. London: Oxford University Press, 1966.
- Ominde, S.H. Land and Population Movement in Kenya. Evanston: Northwestern University Press, 1968.
- Organization for Economic Cooperation and Development. Low Incomes in Agriculture: Problems and Policies. Paris, 1964.
- Parsons, Kenneth H., ed. Land Tenure, Proceedings of the International Conference on Land Tenure and Related Problems in World Agriculture, 1951. Madison: University of Wisconsin Press, 1956.
- Petersen, William. Population. London: The Macmillan Company, 1969.
- _____. "The Demographic Transition in the Netherlands," American Sociological Review, Vol. XXXV, No. 3 (June 1960).
- Ranis, G., and Fei, J.C.H. "A Theory of Economic Development," The American Economic Review, Vol. LI, No. 4 (September 1961).
- Reinhard, Marcel, and Armengaud, Andre. Historia de la poblacion mundial. Barcelona: Ediciones Ariel, 1966.
- Reynolds, Clark W. The Mexican Economy: 20th Century Structure

BIBLIOGRAPHY

- and Growth. Stanford: Food Research Institute, Stanford University, 1968.
- Robertson, M.I. Isobel. "The Occupational Structure and Distribution of Rural Population in England and Wales," Scottish Geographical Magazine, Vol. 77, 31 December 1961.
- Robinson, Alfred J. "Can Economic Growth Be Based on Agriculture?," Indian Economic Journal, Vol. XIII, No. 4 (January-March 1966).
- Rostow, Walt W., ed. The Economics of Take-off into Sustained Growth. New York: St. Martin's Press, 1963.
- Rural Sociological Society. "Dynamics of Rural Population," Rural Sociology, Vol. XIX, No. 1 (March 1954).
- Salisbury, Neil, and Rushton, Gerard. Growth and Decline of Iowa Villages: A Pilot Study. Iowa City: State University of Iowa, Department of Geography, 1963.
- Saville, John. Rural Depopulation in England and Wales 1851-1951. London: Routledge and Kegan Paul, 1957.
- Sawroop, B. "Trends in Land Utilization in Rajasthan 1951-62," Artha Vijnana, Vol. VIII, No. 4 (June 1966).
- Schnore, Leo F. "The Statistical Measurement of Urban and Economic Development," Land Economics, Vol. 37, 1961.
- Schultz, Theodore W. The Economic Organization of Agriculture. New York: McGraw-Hill, 1953.
- _____. Transforming Traditional Agriculture. New Haven: Yale University Press, 1964.
- Sen, A.K. "Peasants and Dualism with or without Surplus Labor," Journal of Political Economy, Vol. LXXIV, No. 5 (October 1966).
- Shimkin, Dimitri B. "Current Characteristics and Problems of the Soviet Union Rural Population" in Roy D. Laird, ed., Soviet Agriculture and Peasant Affairs. Lawrence: University of Kansas Press, 1963.
- Skrubbeltrang, F. Agricultural Development and Rural Reform in Denmark. Rome: Food and Agriculture Organization of the United Nations, Agriculture Studies No. 22, 1953.
- Southworth, Herman J., and Johnston, Bruce F., eds. Agriculture Development and Economic Growth. Ithaca: Cornell University Press, 1967.
- Sovani, N.V. "Review of The Conditions of Agricultural Growth by Ester Boserup," Indian Economic Journal, Vol. 13, April-June 1966.
- Spencer, J.E. Shifting Cultivation in Southeastern Asia. Berkeley: University of California Press, 1966.

BIBLIOGRAPHY

- Stamp, L. Dudley, ed. A History of Land Use in Arid Regions. UNESCO, 1961 (NS.60/III.21/A).
- Stevens, Arthur J. "The Distribution of Rural Population in Great Britain," Transactions, Institute of British Geographers, No. 11, 1946.
- Takekazu, Ogura. Agriculture Development in Modern Japan. Tokyo: Fuji Publishing Company, 1963.
- Thomas, Dorothy S. Social and Economic Aspects of Swedish Population Movements 1750-1933. New York: The Macmillan Company, 1941.
- Thomas, William L., Jr., ed. Man's Role in Changing the Face of the Earth. Published for the Wenner-Gren Foundation for Anthropological Research and National Science Foundation by the University of Chicago Press, 1956.
- Tobata, Seiichi. Japan's Agriculture: Farming Population. Public Information and Cultural Affairs Bureau, Ministry of Foreign Affairs, Japan, 1956.
- United Nations. Estudios sobre la electricidad en America Latina (E/CN.12/630). Mexico, D.F., October 1962.
- _____. Handbook of Population Census Methods. Vol. II, Economic Characteristics of the Population (I/Stat/Series F-15/Rev. 1). New York, 1958.
- _____, Department of Economic and Social Affairs. The Aging of Populations and Its Economic and Social Implications (ST/SOA/Series A/26). New York, 1956.
- _____, Department of Social Affairs. The Determinants and Consequences of Population Trends. Population Studies No. 17 (ST/SOA/Ser. A/17). New York, 1953.
- United States Congress, Joint Economic Committee. Economic Profile of Mainland China. Volume I: General Economic Setting, Economic Sectors, 90th Congress, First Session. Washington, D.C., February 1967.
- _____, Subcommittee on Foreign Economic Policy of the Joint Economic Committee. New Directions in the Soviet Economy. Parts I, II, and III, 89th Congress, Second Session. Washington, D.C., 1966.
- United States Department of Commerce. "Consumer Income: Household Income in 1967 by Selected Characteristics of the Head," Current Population Reports, Series P-60, No. 57, December 17, 1968.
- _____. Farm Population of the United States: 1968, Current Population Reports, Series P-27, No. 40, July 31, 1969.
- Van Aartsen, J.P. "Land Classification in Relation to Its Agricultural Value: A Review of Systems Applied," Monthly Crop

BIBLIOGRAPHY

Report and Agricultural Statistics (International Review of Agriculture). Nos. 7 and 8 and 11 and 12.

Van Bath, B.H. Slicher. The Agrarian History of Western Europe. New York: St. Martin's Press, 1963.

Vance, S.W.E. "Reflections on the Structure and Distribution of Rural Population in England and Wales, 1921-31," Transactions and Papers, Institute of British Geographers, No. 18, 1952.

Weatherburn, C.E. A First Course in Mathematical Statistics. London: Cambridge University Press, 1946.

Weber, Adna F. The Growth of Cities in the Nineteenth Century. Ithaca: Cornell University Press, 1967. [Originally published in 1899.]

Whitney, Vincent H. "Population in Theories of Economic Development" in International Population Conference, Vienna, 1959. The Working Committee of the Conference, Vienna, 1959.

Wilkinson, Thomas O. The Urbanization of Japanese Labor, 1868-1955. Amherst: University of Massachusetts Press, 1965.

Wrigley, E.A. Industrial Growth and Population Change. Cambridge: Cambridge University Press, 1961.

Zelinsky, Wilbur. "Changes in the Geographical Patterns of Rural Population in the United States 1790-1960," Geographical Review, October 1962.

_____. "Rural Population Dynamics as an Index of Social and Economic Development: A Geographic Overview," The Sociological Quarterly, Vol. IV, No. 21 (Spring 1963).

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